GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

# PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. A-3341-000 GTRI/~~GTEX~~ DATE 11/10/82

Project Director: Phil Potts ~~School~~/Lab TAL

Sponsor: Agency for International Development US
Washingotn, DC 20523

Type Agreement: Contract PDC-1406-I-01-1006-00; Work Order #1

Award Period: From 9/17/82 To ~~1/15/83~~ 3/16/83 (Performance) _____ (Reports)

Sponsor Amount: Total Estimated: $ _____ Funded: $ 35,281

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: ~~Water and Sanitation for Health (Project No. 931-1176)~~
see Revision # 2

ADMINISTRATIVE DATA — OCA Contact John W. Burdette x4820

1) Sponsor Technical Contact:

Mr. V. Wehman
Office of Health/Science & Tech Bureau
Agency for International Development
US State Dept.
Washington, DC 20523

2) Sponsor Admin/Contractual Matters:

Edward H. Thomas
Services Operations Division
Office of Contract Management
Agency for International Development
Washington, DC 20523

Defense Priority Rating: NA

Military Security Classification: NA
(or) Company/Industrial Proprietary: NA

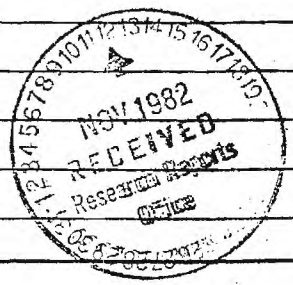
RESTRICTIONS

See Attached _____ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with None proposed

COMMENTS:

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 12/5/83

Project No. A-3341 ~~School~~/Lab TAL

Includes Subproject No.(s)

Project Director(s) Phil Potts GTRI / ~~GIT~~

Sponsor U.S. Agency for International Development

Title Water and Sanitation for Health

Effective Completion Date: 3/16/83 (Performance) (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. Continued by Project No.

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Form OCA 60:1028

# TECHNICAL/MANAGEMENT REVIEW

# OF THE

# AID HAND-OPERATED WATER PUMP PROGRAM

prepared for

The U.S. Agency for International Development

under Contract No. PDC-1406-I-00-1130-00

by

Phillip W. Potts

Senior Research Scientist

Technology Applications Laboratory
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
Atlanta, Georgia 30332

August, 1983

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Atlanta, Georgia 30332

March, 1983

Table of Contents

ACKNOWLEDGMENTS

The author of this report would like to express his appreciation to Mr. F. Eugene McJunkin, Chief, and Mr. Victor W. R. Wehman, Jr., AID hand pump program manager during the past six years, Water Supply and Sanitation Division, Office of Health, Bureau of Science and Technology, U.S. Agency for International Development, Washington, D.C. for the opportunity to serve on the team for the technical/management review of the AID hand-operated water pump program, as described herein. It was extremely enlightening to see the overall progress of the individual countries after technical assistance has ended, and, more importantly, the long-term problems that have arisen. The information gathered during the review will be of tremendous value in improving what the author already considers a very successful technology transfer activity.

A special note of appreciation is appropriate for the following who arranged a hectic schedule on short notice for the review team:

| | |
|---|---|
| Mr. James Meenan | USAID/Sri Lanka |
| Mr. Harold Fernando | Ministry of Local Government, Housing and Construction, Colombo, Sri Lanka |
| Mr. K. B. Gration Marcus Fernando | Ministry of Local Government, Housing and Construction, Colombo, Sri Lanka |
| Mr. Carlos Crowe | USAID/Philippines |
| Mr. Oscar Basa | USAID/Philippines |
| Mr. Gaspar Nepmoceno | Ministry of Local Government, Manila, Philippines |
| Dr. David Calder | USAID/Indonesia |
| Mr. Ellis Franklin | CARE/Indonesia |
| Mr. Donna Krisna | CARE/Indonesia |
| Mr. Richard Dudley | USAID/Honduras |

| | |
|---|---|
| Dr. Oscar Rivera | USAID/Dominican Republic |
| Mr. John Thomas | USAID/Dominican Republic |
| Mr. Manuel Valdez | USAID/Dominican Republic |
| Mr. James Gardner | USAID/Haiti |
| Mr. Frank Temmel | USAID/Haiti |

Appreciation also should be noted to the AID hand pump manufacturers in Nicaragua, Costa Rica, the Dominican Republic, Indonesia, Tunisia, Sri Lanka, Honduras, Ecuador, and the Philippines for their contributions to the AID hand pump program. Even though the following manufacturers were contracted and paid for the production of the pumps there always have been considerable demands of managerial and production worker time that was unforeseen when negotiating the prices of the pumps:

Nicaragua

Complejo Metalurgico Especializado, S.A. (COMETALES)
Jairo Triana Harker (President)
Km. 26 Carretera Nueva a Leon
Managua, Nicaragua

Costa Rica

Mecanizados Mofama
Roger Madriz (President)
(address unknown)
San Jose, Costa Rica

Dominican Republic

Equipo Tecnico Industrial C.A. (ETINCA)
Mr. Tobia Fernandes (Manager)
Calle San Juan de la Maguana No. 102

Apartado No. 158-12
Santo Domingo, Republica Dominicana

Cedeno Industrial, S.A.
Jose Francisco Cedeno (President)
Calle Primera No. 6, Zona Industrial de Herrera
Santo Domingo, Republica Dominicano

Indonesia

P. T. Celco
Tano Tjakrasasmita (Manager)
Jl. Jen. Gatot Subroto 43A
Bandung, Indonesia

Tunisia

Founderies Reunies
Nohsen Nabli (Technical Director)
Route de Sousse - Km. 5
Megrine, Tunisia

Sri Lanka

Somasiri Huller Manufactory
M. D. P. Dias (Managing Director)
18, Parakrama Avenue
Kohuwala, Nugegoda, Sri Lanka

Honduras

Fundicion Y Maquinado, S.A. (FUNYMAQ)
Ricardo Mata (Manager)

Carretera a Chamelecon , Km. 6
San Pedro Sula, Honduras

Ecuador

Tirado Hermanos Cia. Ltda.
Eduardo Tirado (Manager)
Talleros Control Norte Km. 4
Ambato, Ecuador

Metalurgica Ecuatoriana Cia. Ltda.
Rommel Figueroa Diaz (Technical Director)
Apartado 2230
Teodoro Gomez de la Torre 720
Quito, Ecuador

Philippines

Tri-Star Metal Industries
Henson T. Laurel (Vice President)
210 Jaboneros Street
Binondo, Manila, Philippines

# SUMMARY

In September 1982, the Georgia Institute of Technology (Georgia Tech) was contracted to provide a senior international hand pump expert to serve as a member of a technical/management team to review AID hand pump programs in Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic, and Haiti. This report covers the author's activities, findings, conclusions, and recommendations from the review of these hand pump programs. The six sections following the introduction are detailed trip reports from each country visited. The final section contains specific recommendations extracted from the trip reports of each country, as well as general recommendations.

The Sri Lankan manufacturer, Somasiri Huller Manufactory, is marketing the AID hand pump and producing a quality pump at a competitive price ($160 for the shallow-well model and $180 for the deep-well model). At 15 sites visited by the team, 31 pumps were observed, 21 of which were functioning properly and 10 of which were disappointingly inoperative. Of the 10 inoperative pumps all could have been repaired very easily and very quickly had maintenance and repair procedures established by the Sri Lankan Government been followed. Other donors and host country organizations are using the AID hand pump; the private sector is not yet purchasing the pump. Government engineers and technicians, as well as village caretakers, originally trained in installation, operation and maintenance of the AID hand pumps are still operationally involved in the hand pump program.

In retrospect, the AID hand pump program has gone relatively well in Sri Lanka. The maintenance and repair infrastructure implemented by the Sri Lankan Government is having its problems, but these are recognized and are being solved. The manufacturer is fully capable of producing a high quality pump and needs no further technical assistance. Basically, the AID hand pump design is sound except for the rather frequent wearing of foot valves, which should be replaced with a longer lasting mechanism such as that used for the AID hand pump program in the Philippines.

AID hand pumps installed for field monitoring and evaluation in the Philippines are still functioning well and being maintained by village caretakers and provincial engineers. The AID hand pump manufacturer (Tri-Star Metal Industries), unfortunately, has ceased its foundry and machine shop operations for an indefinite period of time. There are, however, numerous foundries and machine shops fully capable of manufacturing the AID hand pump when future orders are submitted to competitive bidding by the Government of the Philippine's Ministry of Local Government. Donors and host country organizations, other than the Barangay Water Program, are not using the AID hand pump in their rural water supply programs.

Overall, the AID hand pump program has gone relatively well in the Philippines. However, the technology transfer effort is not finished. Future orders for the AID hand pump will require limited technical assistance to assure adherence to original specifications. Marketing emphasizing the advantages of the AID hand pump over other commercially available or imported hand pumps has been practically nonexistent. Marketing strategy should be aimed toward promoting the use of the AID hand pump in other AID health programs and making other development agencies (for instance, the U.S. Peace Corps) aware of the effectiveness of AID hand pump programs.

All ten Indonesian AID hand pumps inspected in the field were lubricated and functioning even though one had a badly leaking foot valve. Communities involved in the pilot program are not only able to maintain their hand pumps, they are doing this very well. The original manufacturer of the AID hand pump in Indonesia, P. T. Celco, is still producing the AID hand pump and in sizeable quantities. P. T. Celco is <u>not</u> adhering to manufacturing specifications established during the AID hand pump pilot program.

CARE and its personnel originally trained in installation, operation, maintenance, and repair of the AID hand pump and in water quality analysis in

Indonesia are still operationally involved in an ongoing AID hand pump program. Not only is CARE doing an excellent job in continuing the program in the Bandung area, it has expanded the program to Lombok. Both CARE and the USAID Mission should be congratulated for their diligence.

The AID hand pumps in Honduras are, in general, functioning at test sites. Of 30 pumps examined during the management/technical review team's visit, only two pumps were not functioning. One of the pumps, at La Lima (Mabel Maria Escobar site), was inoperable because of what appeared to be a defective foot valve. The other inoperable pump, at Comayagua (San Nicolas--Campo Balompie site), was over a well that was heavily used and the water level of the well had temporarily dropped below the location of the pump's cylinder. Most of the test pumps were properly lubricated and in good condition. However, several AID deep-well pumps in the Comayagua area, while functioning, had varying degrees of leakage at the pump's foot valve. It is strongly recommended that a foot valve design used with the AID hand pumps manufactured in the Philippines or one of equal (or greater) durability be manufactured and retrofitted to the hand pumps already manufactured.

In retrospect, the AID hand pump program has gone well in Honduras. There have been many problems to contend with in teaching the manufacturer proper production and quality control techniques and in showing government engineers and technicians proper methods of well development as well as hand pump installation, maintenance and repair. However, these problems are inherent in such a development program.

The AID hand pump program is <u>not</u> going well in the Dominican Republic. Pumps of the traditional AID design are still functioning. A modified version of the AID hand pump using PVC drop pipe and a plastic foot valve is not working. Unfortunately, the modified pump is being installed at a rapid rate with approximately 50 percent of the pumps failing within several weeks. As a result, it is imperative that procedures be set into motion to quickly determine the failure points of the modified pump and

then to implement corrective action before significant numbers are installed in the field. If the causes and remedies cannot be quickly determined, the traditional design should be re-instituted or manufacture of the AID hand pump should be halted.

Moyno hand pumps installed by Compassion International on Loganave Island, Haiti are, for the most part, working. However, two out of seven inspected were not working. In absolute terms, to find only two inoperable is not bad considering that these pumps receive no maintenance or repair and are being constantly used. On the other hand, the Moyno pump is designed and advertised to require minimal maintenance; for instance, only the grease in the gear box should be changed during the first four to five years. Unfortunately, there is no such thing as a maintenance-free pump, and the USAID Mission, as the funding agency for the procurement and installation of these pumps at Loganave, should make provisions for at least minimal attention to these pumps. At least on an annual basis, personnel and spare parts should be made available to bring these pumps back to a working condition.

Of the 10 AID hand pumps inspected in Haiti, seven were working. As with the Moyno pump, the AID pumps have very heavy usage. Fortunately, and unlike the Moyno pumps on Loganave Island, the AID hand pumps are being maintained and repaired by Atelier Ecole. Unfortunately, the AID hand pumps are not of top quality and, using hindsight, probably should never have been installed in Haiti. For the future, Georgia Tech field engineers should study a problem of plunger rods breaking at the rod end and do their best to make long-term corrections. Also, any pumps that show weaknesses in the field should be brought up to an acceptable level of quality to minimize maintenance requirements and to provide a more reliable source of water. It should be noted that these problems are not insurmountable and can be resolved by the end of March 1983.

The technical/management review of the AID hand-operated water pump program has been enlightening. There is, however, without a doubt, an obvious need

for short-term follow-up technical assistance in each of the countries visited to implement recommendations made in this report for a long-term technology transfer success. It is recommended, and hoped, that AID/Washington and/or the USAID Missions will authorize and fund this follow-up technical assistance in Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic, and Haiti as early as possible.

# INTRODUCTION

For many rural situations where a protectable spring is not available, hand pumps offer the most economical means of maintaining an accessible, safe water source. However, hand-operated water pump programs in Less Developed Countries (LDC's) have historically met with varying degrees of success; and the sometimes less than satisfactory success record of these programs would indicate that various problems have not been effectively addressed. In one area of India, for instance, when 44 pumps were inspected three years after their initial installation, only 17 were still functioning.1/ This trend was similarly noted in a technical paper on hand pumps prepared under the joint sponsorship of the United Nations Environment Programme (UNEP) and the World Health Organization (WHO)2/ which reported:

> The high rate of abandoned or defective hand pumps is not simply a reflection of poor quality but also of inadequate maintenance and repair. Thirty to eighty percent of pumps out of operation at one time in a hand pump program is a not uncommon experience.

The paper continued by characterizing the shortcomings of these programs as follows:

1. Poor quality of hand pump design and manufacture.
2. Lack of feedback from maintenance to engineering and procurement personnel. Inadequate record-keeping.

1/ "Hand Pump Maintenance," Arnold Percy, International Technology Publication, London, 1977.

2/ "Hand Pumps for Use in Drinking Water Supplies in Developing Countries," Technical Paper No. 10, International Reference Centre for Community Water Supply, Voorburg (The Hague), The Netherlands, July 1977.

3. Poor maintenance skills, lack of training, inadequate tools, lack of transport, and lack of supervision.
4. Invisibility of maintenance and lack of urgency. Users return to their pre-hand pump source. Maintenance supervisors are far removed from scene or need.
5. Lack of appreciation of preventive maintenance. Maintenance seen as repair function.

More recently, a June 1981 newsletter distributed by the International Reference Centre for Community Water Supply and Sanitation[1/] reported:

> Although appreciable progress is being made in many developing countries with regard to well drilling and hand pump installation for rural water supplies, the same is unfortunately not true of the maintenance of pumps once they are installed. In fact, hand pumps break down frequently at alarming rates--up to 60% within one year is no exception--and remain unrepaired for long periods of time because of lack of adequate provisions for maintenance and repair. Concentrated efforts are required if the impact of many hand pump programmes is to continue.

Obviously, while the quality of hand pump design and manufacture remains the foundation of a successful rural water supply program, implementation of an effectively integrated maintenance program also is essential to sustained success. With this in mind, and in response to the need in developing countries for a reliable and improved supply of safer water, the Agency for International Development (AID) initiated a series of contracts with the Battelle Memorial Institute to design and laboratory test a reciprocating shallow- and deep-well pump. A final design was developed and, in late 1976, the Georgia Institute of Technology (Georgia Tech) was

1/ "International Reference Centre for Community Water Supply and Sanitation," N. 122, Rijswijk (The Hague), The Netherlands, June 1981.

contracted by AID to select two developing countries for local manufacturing and field testing. The scope of work included providing technical assistance to foundries and machine shops in the manufacturing operation and evaluating the performance and acceptability of the hand pump when heavily used in field situations.

Nicaragua and Costa Rica were chosen as initial test countries. Local manufacture of the AID hand pump was completed and field trials initiated between January 1977 and September 1979. The AID pump was subsequently determined to be reliable, sturdy, easily maintained, low in cost compared to imports, and capable of being manufactured in developing countries. After completing local feasibility surveys of existing manufacturing capabilities, AID hand pump programs were initiated in the Dominican Republic, Indonesia, Tunisia, Sri Lanka, Honduras, Ecuador, and the Philippines.

In September 1982, Georgia Tech was contracted to provide a senior international hand pump expert to serve as a member of a technical/management team to review AID hand pump programs in Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic and Haiti. This report covers the author's activities, findings, conclusions and recommendations from Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic, and Haiti. The next six sections are detailed trip reports from each country visited. The final section contains specific recommendations extracted from the trip reports of each country as well as general recommendations.

TRIP REPORT: SRI LANKA

SEPTEMBER 20-28, 1982

## BACKGROUND

In October 1979, Georgia Tech was assigned the task of determining the feasibility of locally manufacturing AID hand pumps in Sri Lanka and concluded that adequate market and local manufacturing capabilities were available. USAID/Sri Lanka then contracted with Georgia Tech to proceed with the implementation of the USAID/Sri Lanka hand pump program in March 1980.

A contract was signed thereafter between Georgia Tech and Somasiri Huller Manufactory for the production of 90 AID hand pumps (see Figures 1 and 2). These 90 pumps were manufactured at a unit selling price of $149 (U.S.). Both following assembly and before delivery to preselected sites, each pump was checked in the factory for quality of manufacture and individually tested over a drum of water to conclude the first phase of the project.

The second phase of the project dealt primarily with field testing of the AID hand pumps and involved their installation at sites located around the country where operating conditions might significantly differ. Thirty-nine sites (see Table 1) were chosen from a field of 130 which had been identified by officials of the Government of Sri Lanka. Seventy-nine pumps were eventually installed at the 39 sites.

The manufactured AID hand pumps were continuously monitored and evaluated for overall performance and the resulting data was provided as feedback to the manufacturer to allow any necessary corrections and/or improvements. After changes were made, further monitoring and evaluation took place. Other problems, due primarily to improper installation, maintenance, or repair procedures, were addressed. All levels of the Sri Lankan Government

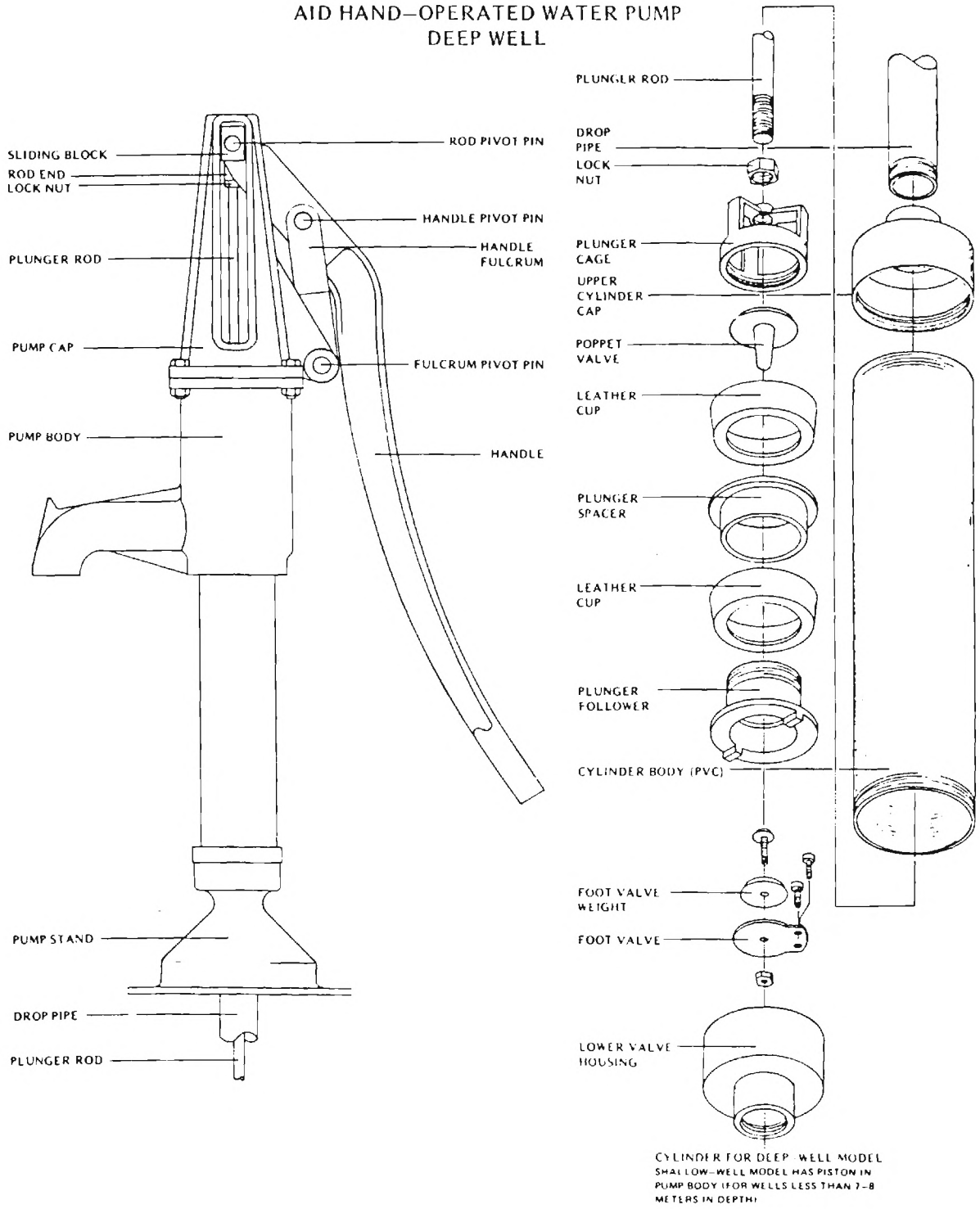
AID HAND–OPERATED WATER PUMP
DEEP WELL
SLIDING BLOCK
ROD END
LOCK NUT
PLUNGER ROD
PUMP CAP
PUMP BODY
PUMP STAND
DROP PIPE
PLUNGER ROD
ROD PIVOT PIN
HANDLE PIVOT PIN
HANDLE FULCRUM
FULCRUM PIVOT PIN
HANDLE
PLUNGER ROD
DROP PIPE
LOCK NUT
PLUNGER CAGE
UPPER CYLINDER CAP
POPPET VALVE
LEATHER CUP
PLUNGER SPACER
LEATHER CUP
PLUNGER FOLLOWER
CYLINDER BODY (PVC)
FOOT VALVE WEIGHT
FOOT VALVE
LOWER VALVE HOUSING
CYLINDER FOR DEEP WELL MODEL
SHALLOW-WELL MODEL HAS PISTON IN PUMP BODY (FOR WELLS LESS THAN 7-8 METERS IN DEPTH)

Figure 1.

AID HAND–OPERATED WATER PUMP
SHALLOW WELL

(For Wells less than 7–8 meters in depth)

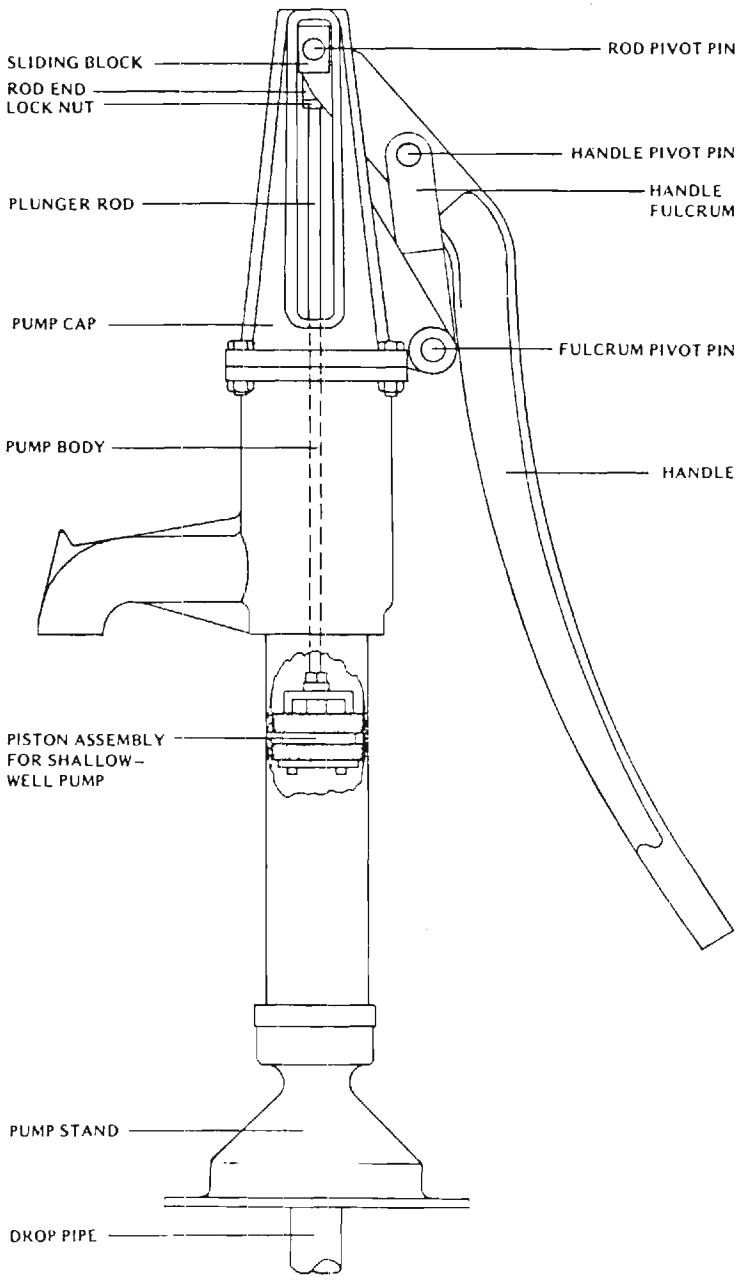


Figure 2.

TABLE 1. SITES SELECTED TO RECEIVE HAND PUMPS,

THEIR TOTAL DEPTH AND DIAMETERS*

| SITE NO. | SITE NAME | REGION | DEPTH, FT. | DIAMETER, FT. |
|---|---|---|---|---|
| 1 | Ukwatta | Kalutara | 19'6" | 7'0" |
| 2 | Vettawa East | Kalutara | 15'0" | 4'0" |
| 3 | Vettawa West | Kalutara | 14'0" | 5'6" |
| 4 | Bollesagama | Kalutara | 18'0" | 5'6" |
| 5 | Adhikarigoda | Kalutara | 12'0" | 6'0" |
| 6 | Serupita | Kalutara | 16'0" | 7'0" |
| 7 | Liyanagoda | Kalutara | 19'6" | 7'0" |
| 8 | Koodapaligoda | Kalutara | 21'6" | 7'0" |
| 9 | Matugama A.G.A. | Kalutara | 8'0" | 5'6" |
| 10 | Ralua | Hambantota | 29'0" | 7'0" |
| 11 | Karamatiya (1DW) | Hambantota | 39'0" | 8'0" |
| 12 | Julampitiya | Hambantota | 21'6" | 7'0" |
| 13 | Oluara | Hambantota | 25'0" | 7'6" |
| 14 | Namaneliya | Hambantota | 16'0" | 7'0" |
| 15 | Ethgalmulla | Hambantota | 24'6" | 6'6" |
| 16 | Panburawa | Hambantota | 23'6" | 7'0" |
| 17 | Kadrupokuna | Hambantota | 23'7" | 9'6" |
| 18 | Labuhengoda (2DW) | Hambantota | 34'0" | 6'0" |
| 19 | Wellipitiya (4SW) | Hambantota | 25'0" | 8'6" |
| 20 | Andrawewa | Hambantota | 15'0" | 7'6" |

TABLE 1 (Continued)

| SITE NO. | SITE NAME | REGION | DEPTH, FT. | DIAMETER, FT. |
|---|---|---|---|---|
| 21 | Sammanthurai #2 | Amparai | 17'0" | 5'0" |
| 22 | Karativu #1 | Amparai | 10'0" | 6'0" |
| 23 | Karativu #2 | Amparai | 16'0" | 5'0" |
| 24 | Periyamullativu | Amparai | 14'0" | 5'0" |
| 25 | Madawalanda | Amparai | 17'0" | 6'0" |
| 26 | Kaeselwatta | Amparai | 16'6" | 5'0" |
| 27 | Weheregama | Amparai | 15'6" | 6'0" |
| 28 | Vijayapura | Amparai | 15'6" | 4'6" |
| 29 | Galapaula | Amparai | 20'0" | 6'0" |
| 30 | Kupuliyadde | Kandy | 9'0" | 5 x 5 square |
| 31 | Botawatta Tikiri | Kandy | 10'0" | 6 x 6 square |
| 32 | Bellwood Colony | Kandy | 16'0" | 6 x 6 square |
| 33 | Uda Deltota | Kandy | 7'0" | 5 x 5 square |
| 34 | Manthuvil #1 | Jaffna | 14'7" | 4'9" |
| 35 | Manthuvil #2 | Jaffna | 14'4" | 4'6" |
| 36 | Kaithady | Jaffna | 18'10" | 11'6" |
| 37 | Fatima Church(2DW) | Jaffna | 28'11" | 10'8" |
| 38 | Vaddukoddai | Jaffna | 18'3" | 5'0" |
| 39 | Kalevaddawathai | Jaffna | 17'7" | 6'8" |

*Note - Unless otherwise specified, all sites constructed with two shallow-well (2SW) pumps.

#DW - indicates number of deep-well pumps.
#SW - indicates number of shallow-well pumps.

infrastructure were provided with additional and/or corrective on-site training.

Effectiveness of the AID hand pump monitoring activities, especially those conducted in the field, was apparent when a final inspection tour was made in December 1981 of five districts (Kalutara, Hambantota, Kandy, Amparai and Jaffna) where the 79 pumps had been installed. At the time of the inspection all but five pumps were found to be in good working order, a 92.4% success rate.

Lastly, the general AID hand pump technology transfer process itself should be mentioned. The process is not complicated and begins with determining the applicability of the technology (the AID hand pump) to be transferred. This phase includes investigating such factors as the need for water supply programs, population densities, and the existence of private or government infrastructures with the capabilities and resources for developing water supply programs. The demand for hand pumps is compared to existing or potential supply sources. Local manufacturing capabilities are analyzed to determine the level of expected quality at a price competitive with other available hand pumps.

If the first phase is positive, the second phase is implemented and involves a relatively small production run to test the true capabilities of the manufacturer. During this phase, the manufacturer is supplied with working drawings, prototypes, and technical assistance in production techniques and quality control procedures. Manufacturing cost data is recorded to assure the manufacturer that it is possible to produce the hand pump at a competitive price and realize a profit. During the different stages of production, quality control checks are required. Completed pumps are tested in-plant for overall performance. If found to be satisfactory, they are installed in the field for performance monitoring and final evaluation. As manufacturing defects are discovered during field testing, information is relayed to the manufacturer and methods are formulated for correcting the manufacturing problems.

Field testing is a necessity for "debugging" the newly manufactured AID hand pumps, although it provides other valuable benefits as well. Because wells must be developed, the hand pump recipients are given on-the-job training in activities such as properly disinfecting and analyzing (both chemically and bacteriologically) well waters, installing pumps over the well, and providing maintenance and repair.

Location of the field testing sites is important. Ideally, the sites should be as close together as is practical for easy monitoring. However, regardless of the proximity of the sites to each other, the locations should provide a large number of users of the pump under the varying conditions to which the pump will be exposed in a large-scale rural water supply program. For instance, in Sri Lanka, it was beneficial to test the AID hand pump in five regions where conditions ranged from very arid (Jaffna and Amparai) to mountainous (Kandy) to tropical where groundwater is relatively abundant (Kalutara and Hambantota).

The use of host country counterparts deserves mention as they have played a major role in each country where the AID hand pump has been introduced for local manufacture, including Sri Lanka. Counterpart organizations are in-country international, national, or regional governmental agencies, development institutions, and/or Private Volunteer Organizations (PVO's) that allow project personnel more efficient utilization of funds. These counterparts carry out the day-to-day operations of the project. At the same time, they provide established working relationships with existing communities, industries, lending institutions, and government departments, thus saving considerable time and effort when establishing operations in a new country. By the conclusion of the project, the counterparts, as well as the manufacturer(s), are self-sufficient and capable of entering full-scale hand pump programs on their own initiative.

In conclusion, the above methodology was used in Sri Lanka as well as in Nicaragua, Costa Rica, the Dominican Republic, Indonesia, Ecuador, Honduras, the Philippines, and Tunisia. As demonstrated in Sri Lanka, this author believes the methodology to be appropriate, workable, and effective.

TRIP ACTIVITIES

Monday, September 20. Delta flight 14 was taken from Atlanta to Frankfurt, Germany, arriving in Frankfurt at 9:05 A.M. on the 21st.

Tuesday, September 21. Air Lanka flight 544 was taken from Frankfurt to Colombo, Sri Lanka, arriving in Colombo at 6:00 A.M. on the 22nd.

Wednesday, September 22. After arriving in Colombo, I checked into the Hotel Lanka Oberoi and then went to the USAID Mission to brief Mr. James Meenan on the purpose of my visit. Shortly thereafter I was joined by the rest of the review team, Mr. Eugene McJunkin (AID/Washington), Mr. David Donaldson (Water and Sanitation for Health Project, Washington, D.C.), and Mr. Ebbo Hofkes (International Reference Center at the Hague, Netherlands). The rest of the day was spent making arrangements for a three-day field trip to see AID hand pump installation sites near Kalutara, Hambantota and Kandy.

Thursday, September 23. The day began by visiting Somasiri Huller Manufactory and its manager, Mr. Pathmasiri Dias. Somasiri Huller Manufactory has just about finished a production order from the German Agency for Technical Corporation (DTZ) for 10 deep-well AID hand pumps which will be tested in the field and compared to several imported pumps before some 600 pumps are ordered for installation in rural areas. The Sri Lankan Ministry of Plans Implementation has ordered 380 AID hand pumps, 50 of which already have been produced, for a rural water supply program in the Kurunegala area of the country. The Sri Lankan National Housing Authority has sent a formal inquiry to Somasiri Huller Manufactory for information on its selling price for 50 AID hand pumps and a delivery schedule. (The probability of this order materializing is reported by Somasiri Huller Manufactory to be high.)

The selling prices for the AID hand pumps being manufactured by Somasiri Huller Manufactory are 3200 rupees (160 U.S. dollars) for the shallow-well

model and 3600 rupees (180 U.S. dollars) for the deep-well model. These were the same prices derived during the Georgia Tech pilot manufacturing even though Georgia Tech actually paid a negotiated price of 149 U.S. dollars per pump (shallow-well or deep-well model). The quality of both the pump components and assembled pumps observed in the plant appeared to be quite good with the manufacturer still adhering to original specifications with one exception (see below). Quality control inspection procedures established earlier by Georgia Tech project personnel were still being observed.

Somasiri Huller Manufactory has made a slight modification to the pump base by adding a flange that is bolted to a second (upper) flange which has the pump's three-inch galvanized iron pipe screwed into it. Thus, the factory can secure the pipe to the upper flange very tightly and, with the use of a joint compound, lessen potential loosening of the pipe from the base when the pump is operating in the field. When the shallow-well pump's foot valve is to be changed, the upper flange is unbolted from the base flange rather than breaking the factory seal between the pipe and the pump base. This modification, shown in Figure 3, deserves further consideration by AID/Washington.

After leaving Somasiri Huller Manufactory, the team travelled to Kalutara where AID pumps were installed during March and April of 1981. We were accompanied by Mr. K. B. Gration Marcus Fernando, Technical Officer, Ministry of Local Government, Housing and Construction (MLGHC) in Colombo. In Kalutara we were joined by Mr. Wijesekara, Superintendent of Construction Works, Kalutara, and Mr. G. Amarawerra, Technical Officer, Kalutara, both of whom were assigned to the District Development Council (DDC) of the Assistant Commissioner of Local Government (ACLG), Ministry of Local Government, Housing and Construction. The District Development Council has provided technical officers (civil engineers) to oversee the development of wells and the installation of hand pumps (using village caretakers) throughout Sri Lanka during Georgia Tech's AID hand pump program there. The District Development Council is responsible for

AID HAND-OPERATED WATER PUMP

WITH MODIFIED BASE AND FLANGED CONNECTION

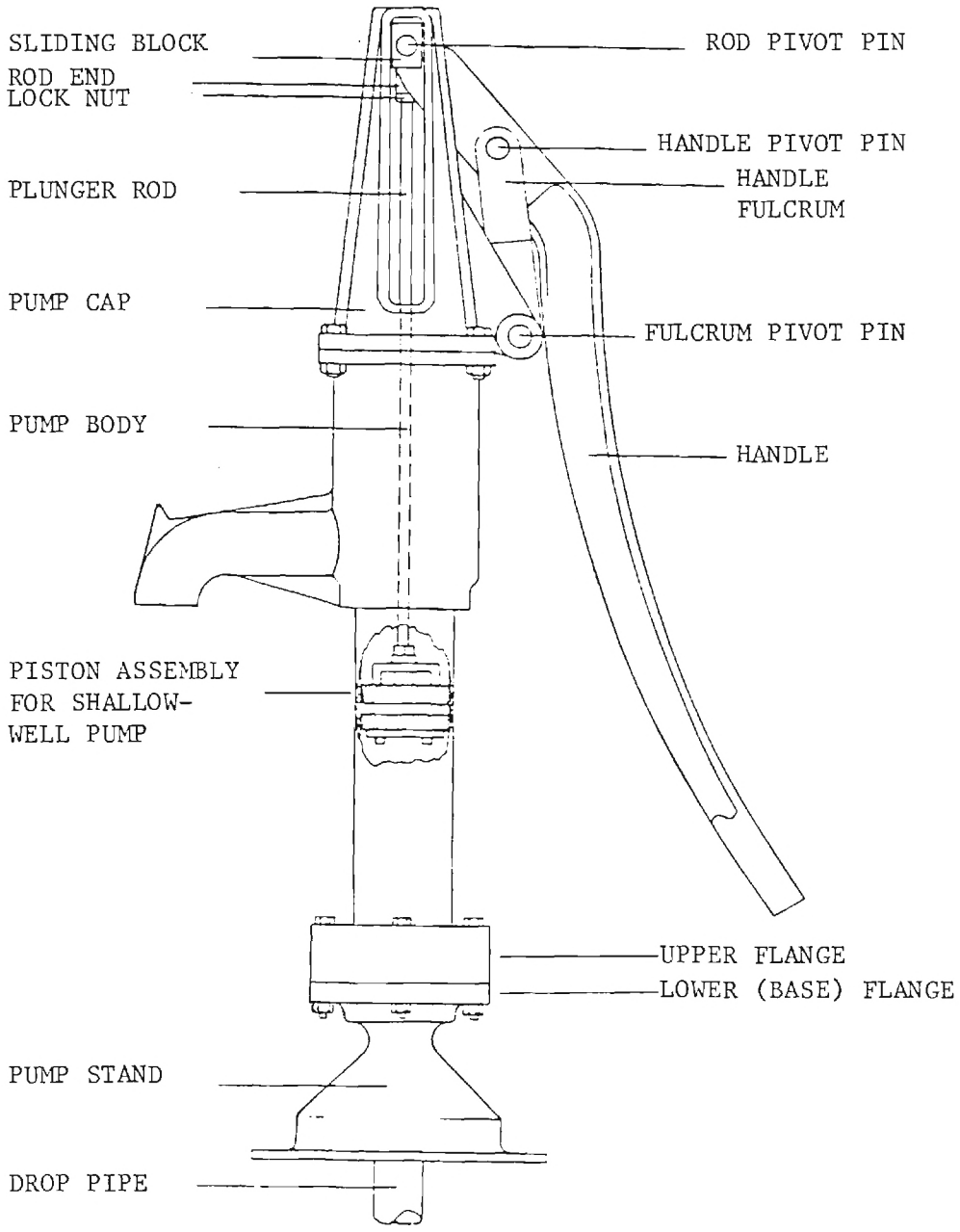


Figure 3.

supplying the village caretakers with spare parts and technical assistance as needed in the repair and maintenance of the hand pumps. (See Figure 4 for Sri Lankan Government's maintenance and repair infrastructure.)

Nine sites were visited in the Kalutara area and the following observations were noted:

1. Adhikarigoda--Two shallow-well models were functioning properly and were lubricated fairly well, but the bolts that hold the cap to the pump body were somewhat loose.

2. Serupita--Two shallow-well models were functioning properly, but lubricated inadequately.

3. Ukwatta--Two shallow-well pumps were not functioning because of what appeared to be inoperable foot valves. Both pumps lacked adequate lubrication.

4. Liyanagoda--Two shallow-well pumps were functioning properly, but with no lubrication. One pump was missing a bushing and a cotter pin.

5. Bollesagama--Two shallow-well pumps were functioning properly, but with no lubrication.

6. Koodapaligoda--One shallow-well pump was functioning properly. The other shallow-well pump was inoperable because of what appeared to be a faulty foot valve. Both pumps lacked adequate lubrication.

7. Matugama--Two shallow-well pumps were functioning properly. Neither pump had adequate lubrication.

8. Vettawa West--Two shallow-well pumps were functioning properly with fair lubrication.

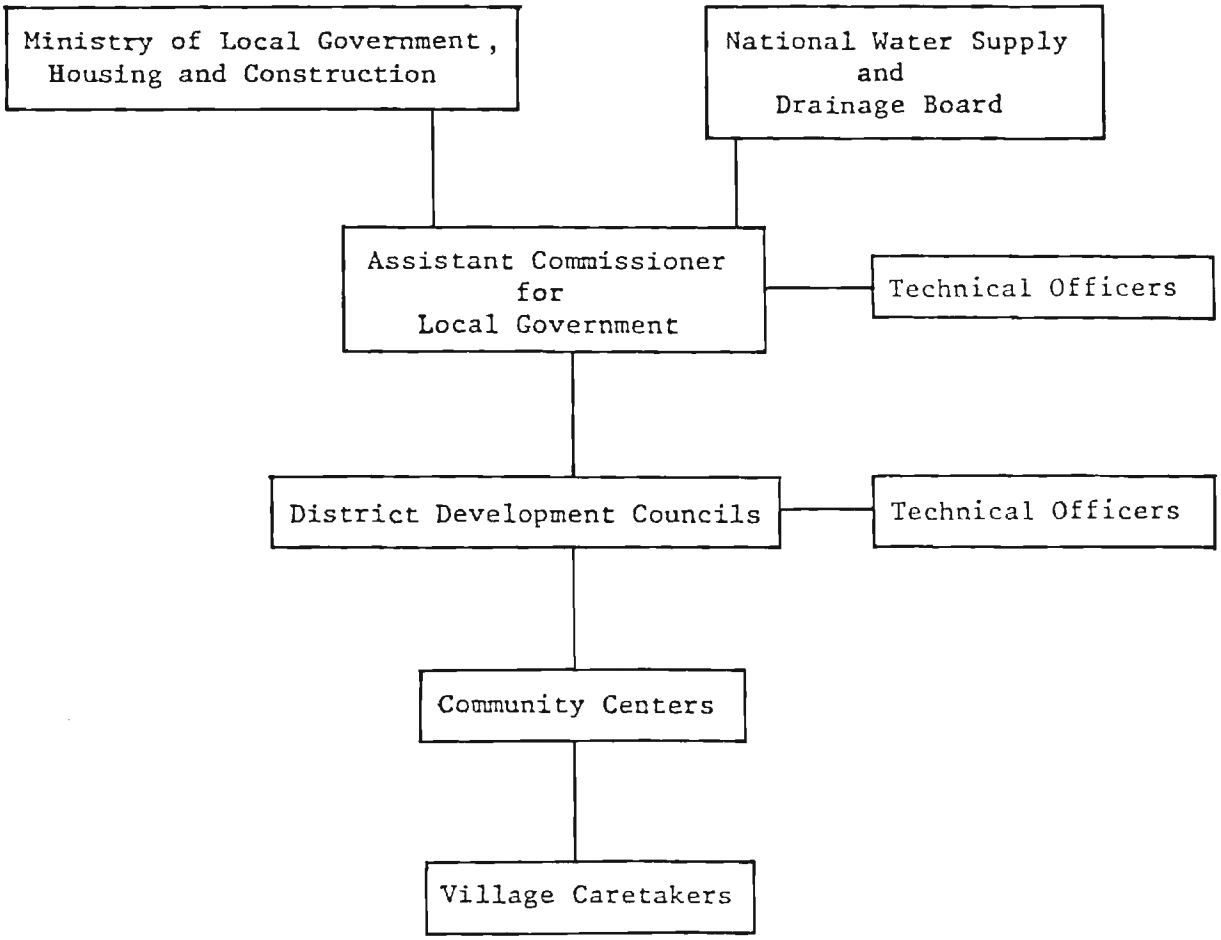


Figure 4. Government of Sri Lanka Infrastructure

9. Vettawa East--One shallow-well pump was functioning properly, while the other pump was inoperative because of what appeared to be a faulty foot valve. Both pumps were lubricated fairly well.

Of the 18 pumps, 14 were functioning properly. The four inoperative pumps appeared to need replacement of their foot valves. In response to why the pumps were not being lubricated, the District Development Council engineers replied that the Government had not provided any funds for purchasing grease. The District Development Council engineers also said the inoperable pumps had not been repaired because the village caretakers had not reported the malfunctions.

None of the 18 pumps were adequately lubricated. This is a discouraging situation when one considers the time and effort the Government of Sri Lanka has put into a workable maintenance and repair capability. On the positive side, the lack of lubrication clearly showed the sturdiness of the AID hand pump. Pins, bushings, and sliding blocks had negligible, if any, wear after 16-18 months of usage, even though there was concentrated friction at these moving parts which increased the stress on the pump and made it much more difficult to operate.

Obviously the maintenance and repair infrastructure established by the Ministry of Local Government, Housing and Construction is not working. In this arrangement, the village caretakers handle minor maintenance and repairs (lubricating the pumps and replacing defective foot valves, leather cups, and fulcrum pins), while the District Development Council handles the more complicated repairs if requested by the village caretakers. Apparently the problem is two-fold: the District Development Councils have not received funds from the Government in Colombo for purchasing supplies such as grease, and there is a communication gap between the village caretakers and the District Development Councils.

After visiting the nine sites in Kalutara the team travelled to Hambantota where we spent the night.

Friday, September 24. This morning Messrs. Potts, McJunkin, Donaldson, Hofkes, and Fernando were joined by Mr. M. S. Isadeen, Superintendent of Construction Works, District Development Council, Hambantota. From Hambantota we visited four sites and made the following observations:

1. Kadrupokuna--One shallow-well pump was functioning properly and one shallow-well pump was inoperative due to what appeared to be a faulty foot valve. Neither of the pumps were lubricated.

2. Ralua--Two shallow-well pumps were functioning properly with some pump components well lubricated and other components void of grease.

3. Karamatiya--One deep-well pump was inoperative due to what appeared to be a disconnected plunger (piston) rod. The pump was fairly well lubricated.

4. Wellipitiya--Three shallow-well pumps were functioning properly and one shallow-well pump was inoperative due to a broken plunger rod. All four pumps were fairly well lubricated.

Of the above nine pumps which were installed in May and June of 1981, six were functioning. Interestingly, the three functioning pumps at Wellipitiya were being heavily used with three to four people waiting their turn at each pump. The three inoperative pumps in the Hambantota area should have been quickly repaired; however, the maintenance and repair procedures have not been followed. As in Kalutara, when questioned why the pumps were not being lubricated, the District Development Council engineers replied that no funds had been provided for purchasing grease. In questioning the District Development Council engineers as to why the inoperative pumps had not been repaired, the reply was that the village caretakers had not notified the District Development Council that they (the village caretakers) needed assistance in repairing the pumps. On the other

hand, several of the village caretakers reported that the District Development Council had been notified, but no action had been taken.

In the afternoon, after inspecting the Hambantota sites, we (Messrs. Potts, McJunkin, Donaldson, Hofkes and Fernando) travelled to Kandy, where we were to look at several sites the next morning.

Saturday, September 25. We (Messrs. Potts, McJunkin, Donaldson, Hofkes and Fernando) were joined in the morning by Mr. C. B. Rambukwelle, Staff Assistant, Assistant Commissioner of Local Government, Kandy, for an inspection of two sites where the following observations were noted:

1. Uda Deltota--Two shallow-well pumps were both inoperative. One pump had the threads stripped where the galvanized iron pipe connects to the pump base. The other pump had what appeared to be a faulty foot valve. Neither pump was lubricated.

2. Bellwood Colony--One shallow-well pump was functioning properly and one shallow-well pump was inoperable. (Villagers reported, however, that District Development Council engineers had worked on the pump four days previously and had taken some parts back to Kandy for their replacement, promising to return soon.) Neither pump had any lubrication.

Mr. Rambukwelle was questioned why the pumps were not repaired or lubricated. He replied that he did not know since he was not the technical person responsible for the pumps and, unfortunately, the technical person was not available since it was Saturday.

After seeing the two sites we dropped Mr. Rambukwelle off in Kandy and travelled back to Colombo. While the maintenance and repair infrastructure has not been shown to be effective, the trip revealed several positive results. Somasiri Huller Manufactory has made a sturdy pump that is

reliable even when used under extreme conditions. The concept of hardened pins and bushings is valid. Villagers have received and accepted the AID hand pump. The foot valve, while inexpensive and easy to change, seems to be the weak point in the pump design.

It also should be noted that while the sites at Kalutara, Hambantota and Kandy appear to be well-constructed with good drainage, the villagers have used the sites for bathing and washing clothes. Thus, a residue of slippery soap has been left on the surface of the well's upperstructure, leaving the upperstructure dangerous to walk or stand on. Also, the access hatches to the wells have a lip to restrict waste water from entering the wells and it has, in some cases, broken apart. The height and width of this lip probably should be increased by at least one inch.

Sunday, September 26. No activity.

Monday, September 27. This morning began by meeting at the USAID Mission with Mr. James Meenan to discuss observations of last week's field trip. At 10:00 A.M., accompanied by Mr. Meenan, the team met with Mr. N. D. Peiris (Chairman), Mr. T. B. Madugalle (General Manager) and Mr. D. E. F. Jayasooriya (Deputy General Manager) of Sri Lanka's National Water Supply and Drainage Board (NWSDB). Through Technical Officers assigned to the offices of the Assistant Commissioner of Local Government and District Development Councils, this agency provides technical expertise to water projects in the various districts of the country. The maintenance and repair infrastructure was the major topic discussed. Mr. Peiris explained that changes were already in motion which would be voted on during a National Water Supply and Drainage Board meeting on Friday, October 1.

In the afternoon the team met with Mr. Harold Fernando, Senior Assistant Secretary, Ministry of Local Government, Housing and Construction to discuss observations of last week's field trip. During this meeting Mr. Fernando provided the proposed maintenance and repair procedures which will

be voted on by the National Water Supply and Drainage Board October 1 (see Attachment 1). The procedures are essentially the same as established earlier except that the District Development Councils will provide trained, mobile pump mechanics to work solely with village caretakers in assuring that hand pumps are kept operational. The Ministry of Local Government, Housing and Construction will initially fund the provision of the pump mechanics for three years. After three years the District Development Councils will be expected to generate their own funds through some form of taxation to pay for the pump mechanic's services. While the revised procedures are being voted on, implemented, tested for effectiveness and revised as necessary, Mr. K. B. Gration Marcus Fernando, Technical Officer, Ministry of Local Government, Housing and Construction, Colombo, will follow up on the deficiencies noted during the field trip and see that the deficiencies are corrected.

Tuesday, September 28. Air Lanka flight 302 was taken from Colombo to Singapore.

Wednesday, September 29. Philippine Airlines flight 502 was taken from Singapore to Manila to conclude the AID hand pump review in Sri Lanka and to begin a similar one in the Philippines.

## CONCLUSIONS AND RECOMMENDATIONS

1. The majority of the AID hand pumps inspected during this trip to Sri Lanka are still operating 14-18 months after installation. At 15 sites visited by the team, 31 pumps were observed, 21 of which were functioning properly and 10 of which were disappointingly inoperative. Of the 10 inoperative pumps all could have been repaired very easily and very quickly had the maintenance and repair procedures established by the Sri Lankan Government been followed.

   Replacement of defective foot valves and proper lubrication of the pumps now needs immediate attention by both the USAID Mission and the

Government of Sri Lanka. The Government of Sri Lanka admirably recognizes the shortcomings of its maintenance and repair infrastructure and is taking steps to correct its deficiencies. However, several months will most likely be required to hire and train pump mechanics for the areas where AID hand pumps are located. Until the pump mechanics are carrying out their functions effectively, it is recommended that the USAID Mission make someone available to monitor the pumps on a monthly basis with timely reporting to the District Development Councils and the Ministry of Local Government in Colombo of any pumps that cannot or are not being maintained and repaired.

2. With the exception of a modification to the pump base, the manufacturer, Somasiri Huller Manufactory, is still producing the AID hand pump according to specifications with proper quality inspections and the use of jigs and fixtures for interchangeability of spare parts. The advantage of this modification is that the pipe section of the pump body can be screwed into a threaded flange, sealed with pipe compound and/or Teflon tape, and then bolted to the base which also has a flange cast at its top to prevent loosening and resulting leakage of water that sometimes occurs where the galvanized iron pipe now screws into the base. The disadvantage of this modification is that a gasket is required where the base bolts to the top flange and it probably will have to be replaced anytime the pump base is unbolted from the rest of the pump (for instance, when the foot valve is replaced or repaired in the shallow-well pump). The Somasiri Huller Manufactory modification, overall, has been well thought-out and should be considered for adaptation on all AID hand pumps.

Of much greater concern is the short life of the flapper valve used with the AID hand pump. It is highly recommended that a foot valve design (see Figure 5) used with the AID hand pump manufactured in the Philippines or one of equal (or greater) durability be used on all AID hand pumps. The Philippine foot valve has shown very good results in laboratory tests at Georgia Tech, and reports from the field show similar results.

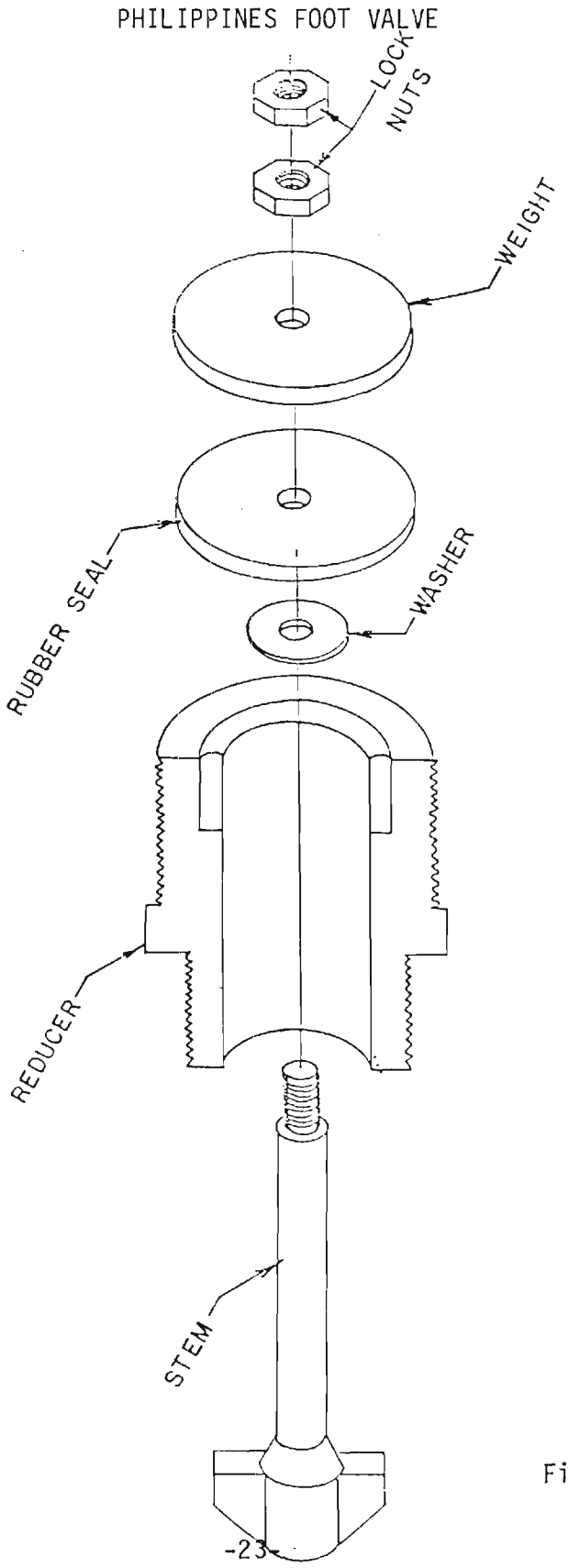
PHILIPPINES FOOT VALVE
LOCK NUTS
WEIGHT
RUBBER SEAL
WASHER
REDUCER
STEM

Figure 5.

3. Other donors and host country organizations are using the AID hand pump and the manufacturer sponsored by the USAID Mission through technical assistance from Georgia Tech. Somasiri Huller Manufactory is now completing a 10-pump order for the German Agency for Technical Cooperation (DTZ). These will be tested in the field and compared to several imported pumps before some 600 pumps are ordered for installation in rural areas of Sri Lanka. The Sri Lankan Ministry of Plans Implementation has ordered 380 AID hand pumps, 50 of which have been produced for a rural water supply program in the Kurunegala area of the country. The Sri Lankan National Housing Authority has sent a formal inquiry to Somasiri Huller Manufactory for information on its selling price for 50 AID hand pumps and a delivery schedule. Importantly, the Sri Lankan Ministry of Local Government, Housing and Construction has endorsed the AID hand pump for use in Sri Lanka because (1) the manufacturer is producing a high quality product appropriate to Sri Lanka and (2) the local manufacture of the pump offers benefits not available through imports (lower procurement costs, readily available spare parts, in-country employment generation, and reduction of foreign exchange requirements).

4. While international donors and host country organizations are purchasing the AID hand pump manufactured by Somasiri Huller Manufactory, the private sector has not purchased the pumps. This is because (1) the pumps are too expensive for most individual rural families and (2) Somasiri Huller Manufactory has concentrated its marketing efforts where the market appears to have the most potential, international donors and host country governmental organizations.

5. Communities involved in the pilot manufacturing and field installation program are presently trying but not succeeding in maintaining the hand pumps because District Development Councils do not yet have the funds to purchase the most basic supply items, such as grease, for the village caretakers. This situation, hopefully, should change by December 1982 if the National Water Supply and Drainage Board in

cooperation with the Ministry of Local Government, Housing and Construction adopts a revised maintenance and repair infrastructure that provides a pump mechanic to work with village caretakers.

6. The Assistant Commissioner of Local Government and District Development Council Technical Officers, as well as the village caretakers originally trained in installation, operation and maintenance of the AID hand pumps are still operationally involved in the hand pump program. They appear competent to carry out their duties in these areas of responsibility with the realization of sufficient funds to purchase supply items and the provision of the proposed pump mechanic.

7. The pricing structure of the AID hand pump has not changed since the initial order with Somasiri Huller Manufactory under the USAID pilot manufacturing program ($160 for the shallow-well model and $180 for the deep-well model).

8. The Sri Lankan Government is still maintaining an active role, along with the pump manufacturer, Somasiri Huller Manufactory, in the overall technology transfer effort. However, the USAID program manager reports that the USAID role has been completed for the most part since USAID's main intent was to establish local manufacturing capabilities, not carry the Government through a long-term, continuing rural water supply program.

   Local manufacturing capabilities were established and, in addition, the program also assisted the Government in addressing related issues of training, maintenance, villager acceptance of the pumps, and institution building. Other donors who were working on rural water supply systems for Sri Lanka were also aided by the program in selection of an appropriate hand pump, development of water sources, and water quality analysis. Importantly, the AID hand pump program permitted the Government of Sri Lanka to implement its Decade Plan for rural

water through a rapid impact approach that allowed installation of hand pumps while preparing for longer term design and construction of piped water systems in more densely populated areas.

9. Even though the USAID Mission has, for the most part, completed its role in the transfer of the AID hand pump technology to Sri Lanka, the Mission is keeping up with the current events of the technology transfer effort. During conversations with various Mission personnel, it was learned that the Mission, including the Director, considers the AID hand pump program as one of its more successful programs. Moreover, the program has been viewed as one that has been particularly attractive because it contains benefits of interest to several of the Mission offices (Capital Development, Health, and Rural Development, for example) rather than just the office that managed the program (Capital Development).

10. In retrospect, the AID hand pump program has gone relatively well in Sri Lanka. The maintenance and repair infrastructure implemented by the Sri Lankan Government is having its problems, but these are recognized and are being solved. The manufacturer is fully capable of manufacturing a high quality pump and needs no further technical assistance. Basically, the AID hand pump design is sound except for rather frequent wearing of foot valves. These should be replaced with a longer lasting mechanism such as that used for the AID hand pump program in the Philippines.

My No. LG/WS/92

23rd September, 1982.

ATTACHMENT 1

PROPOSED MAINTENANCE AND REPAIR INFRASTRUCTURE

Chairman

D.D.C.,

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## Maintenance of Community Wells

Safe drinking water is now provided in rural areas through covered community wells which are installed with hand pumps. Some of these wells, particularly in the dry zone are tube wells, while others are shallow dug wells.

2. It is essential that these wells should be properly maintained in order to ensure a satisfactory and continuous level of service. This maintenance involves on the one hand the maintenance of the hand pump and the well, and on the other the maintenance of the quality of water.

3. This maintenance of community wells is the direct responsibility of the Development Councils and other local authorities concerned, while the National Water Supply & Drainage Board (NWSDB) will have overall supervisory responsibilities, and will provide technical assistance and advice to local authorities.

4. This maintenance function of the Development Council will be at the following levels :

4.1 The Well Caretaker

4.1.1. This is a voluntary village level worker (either male or female), normally resident close to the well. The Caretaker is a member of one of the Voluntary Organisations represented in the Gramodaya Mandalaya, and will normally be from the Community Centre or the Rural Development Society.

4.1.2 The detailed duties and responsibilities of the Caretaker will sent to you. These will broadly cover the following areas -

Security of well and general cleanliness of surrounding area.
Simple maintenace activities.
Maintenance of necessary records.
Maintenance of some stores.
Contacting persons concerned when necessary to attend to maintenance work.
Assisting persons who come to attend to maintenance work.
Keeping the Voluntary Organisation concerned informed regarding the use and maintenance of the well.

4.1.3 All Caretakers will be trained by the NWSDB to carry out such maintenance work.

4.2. <u>The Community Centre or other Voluntary Organisation</u>.

4.2.1 The Community Centre or other Voluntary Organisation will have overall responsibility for the management of the community well, through a Caretaker.

4.2.2 Its general duties and responsibilities will cover the following -

Ensuring that a Caretaker is available for the well.
Ensuring that the Caretaker performs his/her duties satisfactorily.
Ensuring that water quality tests are regularly done and necessary follow up action taken.
Ensuring that water from the well is available to all users in the area.

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Promoting the use of safe drinking water in the community.

Liassing with the D.D.C. sub-office, the A.C.L.G. the Regional Manager, NWSDB in matters concerning well maintenance.

Assisting in health work in the community, with Health Volunteers and any other methods.

Organising Voluntary Labour when required.

Collecting Voluntary contributions from users of well to cover small expenses.

Keeping the Gramodaya Mandalaya and D.D.C. sub-office informed of well maintenance activities.

4.3. The Pump Mechanic

4.3.1 The Pump Mechanic will be a paid employee of the District Development Council. Generally a Pump Mechanic will cover about 100 Community wells for maintenance work. Presently under the UNICEF programme for community wells a few Pump Mechanics have been attached to the Development Councils concerned, and could be attached to convenient D.D.C. Sub-offices. More such Pump Mechanics will have to be recruited as the community wells programmes expand. All these Pump Mechanics will be trained by the NWSDB.

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4.3.2 The duties and responsibilities of the Pump Mechanic will generally cover -

Regular visits to every community well.

Attending to pump repairs, major ones being done in consultation with the R.M., N.W.S.D.B.

Collection of water samples for water quality testing, and their transport.

Maintenance of proper records.

Maintenance of adequate tools, spares and materials.

Working in close liaisson with the Community Centre (or other Voluntary Organisation concerned), and with the A.C.L.G. and the R.M., N.W.S.D.B. through the D.D.C. sub-office.

4.4. D.D.C. Sub-office

4.4.1 The D.D.C. Sub-office will generally attend to maintenance work on community wells through its Technical Officers. These Technical Officers will be trained by the N.W.S.D.B. both in the maintenance of Community wells as well as in their construction.

4.4.2 The duties and responsibilities of the D.D.C. Sub-office will generally cover the following -

Co-ordination of maintenance work with all the Community Centres and other Voluntary Organisati concerned in the area.

Carrying out sanitary surveys where required, in consultation with the M.O.H.

Keeping the Gramodaya Mandalayas concerned regularl informed of well maintenance activities and related matte

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Supervising work of Pump Mechanic.
Having close liaisson with the D.D.C., the A.C.L.G. and the R.M., N.W.S.D.B.
Maintaining proper records.

4.5. Assistant Commissioner of Local Government

4.5.1 The A.C.L.G. in his capacity as Assistant/Deputy Secretary of the D.D.C. will have certain dutoes and responsibilities in respect of well maintenance. The Technical Officers of the A.C.L.G. will be trained in both construction and maintenance of Community wells.

4.5.2 The duties and responsibilities of the A.C.L.G. will generally cover the following -

Keeping the persons concerned informed of government policies in the water supply sector.
Planning work for the sector in the district.
Having a supervisory responsibility on maintenance of community wells, and for this purpose carrying out necessary test checks.
Organising district level training programme, seminars etc.

4.6 Regional Manager, N.W.S.D.B.

4.6.1 The R.M., N.W.S.D.B. will carry out the duties and responsibilities of the N.W.S.D.B. in the maintenance of community wells. This work will be directly handled by the Mechanical Engineer, and the Chemist in the Regional Office, under the supervision of the R.M.

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4.6.2. The duties and responsibilities of the R.M. will generally cover the following -

Undertaking major repairs of pumps.

Testing of water quality.

Organising the training of local government staff and Well Caretakers.

Giving technical advice on maintaining water qualit and conducting of sanitary surveys.

Maintaining necessary records in respect of wells.

4.7. The Gramodaya Mandalaya

4.7.1 The Gramodaya Mandalaya will be regularly informed of community well maintenance activities, through the respective Community Centres and other Voluntary Organis as well as through the D.D.C. Sub-office. The Gramodaya Mandalaya will therefore be in a position to examine wor in the water supply sector and advice on further work to be done bothein planning of the sector and in the maintenance adtivities.

4.8. The District Development Council

4.8.1 The overall reponsibility for maintenance of communi wells lies with the D.D.C.

4.8.2 The main duties and responsibilities of the D.D.C. will be related to -

Recruitment of staff required.

Making the necessary institutional arrangements.

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Making arrangements for any water rates or levies to cover maintenance costs.

Making payment for services and supplies connected with well maintenance.

General co-ordination of all well maintenance work in the district.

Maintenance of records necessary for proper management of maintenance activities.

5. I shall be grateful if you will note the general arrangements explained above for further action to be taken on these lines. Specific arrangements regarding maintenance of wells will follow, commencing with the districts where community well programmes are already under implementation. I am copying this letter to all the D.D.C. Sub-offices with extra copies so that the other relevants institutions too could be informed.

R. Paskaralinga,
Secretary,
Ministry of Local Government, Housing and Construction.

1.c. Chairman, N.W.S.D.B. - for information. A programme will have to be worked out for the D.D.CC to handle the maintenance of all Community wells, and for the N.W.S.D.B. to carry out functions indicated above. Please be good enough to get the officials concerned to work out such a programme, district by district.

1.c. UNICEF Representative - for information.

1.c. C.L.G. - for information.

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1.c. A.C.L.G., ..... for information and for necessary follow up action. Extra copies of this letter are sent for distribution among Community Centres and other Voluntary Organisations that are presently involved in rural water supply.

1.c. Authorised Officer,
D.D.C. Sub-office, - for information. Extra copies of this
..... letter are sent for distribution among Gramodaya Mandalayas.

1.c. Regional Manager,
N.W.S.D.B.,
.....

TRIP REPORT: THE PHILIPPINES

SEPTEMBER 29-OCTOBER 5, 1982

## BACKGROUND

In March 1979, Georgia Tech was assigned the task of determining the feasibility of local manufacture of AID hand pumps and other rural water supply devices in the Philippines. In December 1980, after concluding that adequate market and local AID hand pump manufacturing capabilities existed, a second trip was taken by Georgia Tech personnel to the Philippines to work with the USAID Mission in developing a hand pump program appropriate to USAID's Barangay Water Program (BWP).

In May 1981, AID/Washington issued Order of Technical Direction (OTD) No. 40 to its Water and Sanitation for Health (WASH) Project contractor, Camp Dresser and McKee. OTD No. 40 essentially called for the following:

1. Selection of and technical assistance to manufacturers for the production of 250 AID hand pumps and 400 two-inch diameter cylinders for deep-well hand pumps.

2. Establishment of a training program and training of local technicians and engineers in installation of up to 20 AID hand pumps.

3. Preparation of a section in the BWP Operations Manual covering hand pump installation, maintenance and repair.

4. Participation as a principal resource speaker in a training seminar for Ministry of Local Government engineers and technicians, a BWP contracted architectural and engineering firm, and USAID engineering personnel on hand pump installation, maintenance and repair.

5. Preparation of a section in the BWP Operations Manual covering, step-by-step, site selection and well development.

6. Participation as a principal resource speaker in a training seminar for Ministry of Local Government engineers and technicians, a BWP contracted architectural and engineering firm, and USAID engineering personnel on well design and construction.

Georgia Tech was contracted by Camp Dresser and McKee through its Water and Sanitation for Health Project in June 1981 to carry out the above activities. Work on the hand pump components began in early July 1981. Two hundred and fifty hand pumps and 400 two-inch deep-well cylinders were produced, tested, and accepted on behalf of AID by Georgia Tech over the following ten months. Five shallow-well and five deep-well pumps were installed in the field between November 13, 1981 and December 3, 1981, and monitored by Georgia Tech and USAID/Manila personnel. Monitoring is now continuing under USAID/Manila supervision.

The hand pump manual was prepared and addressed pump operation, sanitary site selection, well disinfection, monitoring, and pump installation, maintenance, and repair. The site selection and well development manual also was prepared and addressed basic hydrogeology, well site selection, water well design, well construction, installation of plastic well casing, casing sealing, well development, testing, maintenance, rehabilitation and abandonment, well records, and water well construction standards.

One training seminar, covering both hand pump installation, maintenance and repair and well design and construction, was held in April 1982.

TRIP ACTIVITIES

Wednesday, September 29. Upon arrival in Manila, Philippines from Sri Lanka, the technical/management review team of Mr. McJunkin, Mr. Donaldson,

and Mr. Hofkes and myself checked into the Hotel Silahis. The four of us then met briefly with Mr. Carlos Crowe at the USAID Mission to discuss our schedule for the next several days.

Thursday, September 30. Messrs. McJunkin, Donaldson, Hofkes and I were picked up at the Hotel Silahis by Mr. Oscar Basa (USAID mechanical engineer) and a USAID driver. Mr. Basa had previously been heavily involved as a USAID counterpart (along with Philippine Ministry of Local Government staff) in Georgia Tech's establishment of local manufacturing capabilities. He has continued to monitor the pump's performance in the field since Georgia Tech's project participation ended. Mr. Basa, further, is deeply committed to the AID hand pump technology transfer concept and has been quite instrumental in what Georgia Tech project personnel consider to be a very successful, worthwhile activity in the Philippines.

From the Silahis Hotel we went to the Philippines Valve Manufacturing Company to meet with Mr. Rene Galera, Vice-President for Technical Operations. Mr. Galera was previously with Tri-Star Metal Industries and had direct supervision over the manufacture of the AID hand pumps in the Philippines. However, due to a number of factors including the reorganization of top management and a dissatisfaction with a major client, Tri-Star later decided to shut down its foundry and machine shop for the near future. Mr. Leong Lam, the Executive Vice-President and General Manager of Tri-Star, reportedly would like to continue assembling the pump to guarantee a quality product, but would subcontract the casting and machining. As a result, Mr. Galera is the most knowledgeable and appropriate person in the Philippines for future orders of the AID hand pump.

Philippine Valve Manufacturing Company is a newly formed subsidiary of Luzon Foundry, a large foundry specializing in bronze and aluminum castings. At present, the company is marketing such products as iron gate valves and pipe fittings. Because its operations are relatively new, the company is not yet fully equipped. However, a full complement of machinery is on order. During a quick inspection of the plant the following resources were observed:

- 1 one-ton capacity induction furnace
- 1 small cupola (coke fired)--240 kilogram capacity
- 1 pattern making department
- 6 automatic mold making machines
- 1 tumbling shot blasting machine
- 1 table shot blasting machine
- 4 lathes
- 2 tapping machines
- 1 multiple drill

Reportedly, a shaper/planer was in the plant; however, I did not see it. The above, along with what was available next door at Luzon Foundry, is sufficient for AID hand pump production if the size of the order is not too large and the delivery date not too tight (USAID and/or the Ministry of Local Government should investigate the company's overall production capacity and backlog of production orders closely as time prohibited such an investigation during this brief trip). Regardless of the capabilities of Mr. Galera and Philippines Valve Manufacturing Company, however, future AID hand pump procurement will be obtained through competitive bids. Thus, any present evaluation of foundries/machine shops is somewhat academic.

We later met with Mr. Gaspar Nepmoceno, BWP Project Director, at the Ministry of Local Government. Mr. Nepmoceno was of the opinion that the AID hand pump (called the Tri-Star pump or the BWP pump in the Philippines) was much more durable and stronger than six or seven commmercially available hand pumps in the Philippines, which usually last only three to six months. Mr. Nepmoceno reported that 240 AID hand pumps had been distributed to provinces where the BWP is active, but few have been installed in the field to this date because piped water systems have priority over hand pumps.

Friday, October 1. Mr. Basa and a USAID driver picked us (Messrs. Potts, McJunkin, Donaldson, and Hofkes) up at seven o'clock at the Silahis Hotel. We then drove to an area north of Manila for inspection of several AID hand

pump installations. Upon arrival in the province where the installations were located, we picked up the provincial engineer responsible for maintenance and repair of these hand pumps. We inspected four AID hand pump installation sites plus several Magsaysay[1/] (with AID deep-well cylinders) and Jetmatic installation sites as well. Observations of the AID hand pump installations were as follows:

1. San Carlos/Candada--One shallow-well pump was examined. It was working well and was properly lubricated. Even though heavily used, the foot valve was holding well. Sliding blocks, however, were slightly worn. The upperstructure looked good.

2. Lanary/Candada--One shallow-well pump was examined. It was working well and was properly lubricated. Heavily used, the foot valve was holding well, but the sliding blocks were slightly worn. Upperstructure looked good.

3. Santa Monica/Santa Rita--One shallow-well pump was working well. The sliding blocks and fulcrum pin, however, were gone (replaced with a long bolt). No lubrication was seen. Upperstructure looked good, and the foot valve was holding well.

4. Lubao/Santo Catalina--One shallow-well pump was working well and was properly lubricated. Although heavily used, the foot valve was holding well. Upperstructure looked good.

Saturday, October 2. Mr. Basa and a USAID driver again picked us (Messrs. Potts, McJunkin, Donaldson and Hofkes) up at the Silahis Hotel. We then drove to an area south of Manila for an inspection of several AID hand pump installations. Again, upon arrival in the province where the installations were located, we picked up the provincial engineer responsible for maintenance and repair of the hand pumps. We then looked at two AID hand pump

1/ The Magsaysay pump utilizes locally-available materials for the upperstructure such as cement, pipe fittings, and a wooden beam for a handle.

installations, plus several sites where there were Magsaysay and Jetmatic pumps. Observations of the AID hand pump installations were as follows:

1. Ilayang Iyam--The status of one deep-well pump was unknown as a locked building (an extension of a school) had been constructed around the pump installation. The pump will be moved to another site but reportedly has a broken fulcrum handle due to unknown circumstances.

2. Ilayang Talim--One deep-well pump was working well and was properly lubricated (although with coconut oil instead of grease). The pump was heavily used, with the foot valve holding well. Upperstructure looked good.

From these observations, it can be concluded that the AID hand pump was well manufactured in the Philippines and is sturdy and reliable. The hardened pin and bushing concept is valid (especially if lubrication is provided), and the pump is appropriate for the Barangay Water Program. The pump (both the shallow-well and the deep-well model) has been modified to include a poppet-type foot valve (see Figure 5) which seems to be a considerable improvement over the traditional flapper valve.

The Magsaysay hand pump (see Figure 6) is included in BWP activities where wells are extraordinarily deep (100-200 feet static water level); and those observed in the field were working well. Interestingly, this pump has roller bearings at the fulcrum point of the handle, which cuts down friction considerably. The idea of using roller bearings has been discussed from time to time with AID/Washington officials in the AID hand pump; however, this approach has not been laboratory tested, and roller bearings, in many cases, would have to be imported by developing countries.

The Jetmatic hand pumps (trade name Fuji, Dragon, Lucky, Wilson) are widely available throughout the Philippines and spare parts can be purchased at most hardware stores. This is the only pump available through the Rural

THE MAGSAYSAY PUMP

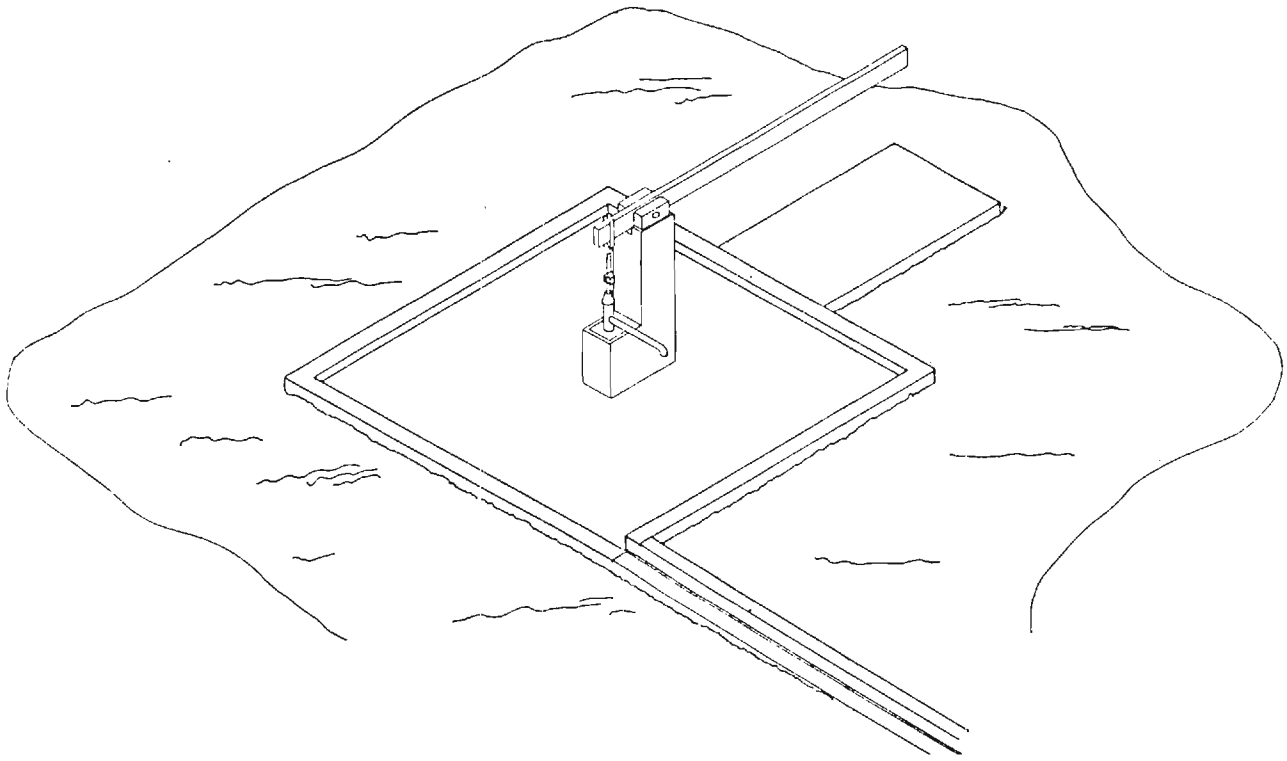

Figure 6.

Waterworks Development Corporation and is designed for use only in wells where the water table is 25 feet or less. The pump uses a four-inch rubber cup which will not form a seal with the cylinder walls when it has worn down even slightly. This, coupled with a frequent leaky foot valve, requires that the pump sometimes be primed daily or even more often. The local (provincial) engineers who install Jetmatics say that the expected lifetime of a pump used by an average of ten households (sixty people) is about three years. The most common causes of failures are broken cast parts and worn-out bearing surfaces.

Sunday, October 3. No activity.

Monday, October 4. This day was spent writing this report and making arrangements to travel to Indonesia October 6 for a review of the AID hand pump program in that country.

Tuesday, October 5. A debriefing was held this morning among Messrs. Potts, McJunkin and Donaldson and Mr. Crowe at the USAID Mission and covered the observations of the Friday and Saturday field trips. Of special concern was the slow progress of installation of the remaining AID hand pumps in the BWP provincial areas. Mr. McJunkin reported later in the day that these installations would be accelerated through their inclusion in other AID programs that use hand pumps.

Wednesday, October 6. Garuda flight 937 was taken from Manila to Jakarta, Indonesia.

## CONCLUSIONS AND RECOMMENDATIONS

1. AID hand pumps installed for field monitoring and evaluation between November 13, 1981 and December 3, 1981, in the Philippines are still functioning well and being maintained by village caretakers and provincial engineers. Of the 10 test sites included in the pilot installations, six were visited. Of the six sites visited, four pumps were in

exceptionally good condition. One pump was functioning but had lost one of its sliding blocks and a lock nut that fastens the block onto the fulcrum pin. The pin and a second sliding block had been retained by the caretaker, who had replaced the entire mechanism with a long bolt. One pump was not accessible for inspection because a locked building had been constructed around it. The fulcrum handle for this last pump was reportedly broken due to unknown reasons.

The pumps were being used by large numbers of rural villagers and were preferred over a rope and bucket or other available pumps experienced in the past, such as Jetmatic or pitcher pumps.

2. Unfortunately, the AID hand pump manufacturer (Tri-Star Metal Industries) has ceased its foundry and machine shop operations for an indefinite period of time. There are, however, numerous foundries and machine shops fully capable of manufacturing the AID hand pump when future orders are submitted to competitive bidding by the Ministry of Local Government. Also, Mr. Rene Galera, a metallurgist and supervisor of Tri-Star's manufacture of the AID hand pump, is now with a competitive foundry that would like to handle future orders of the AID hand pump if it can successfully enter a competitive bid. Further, Mr. Oscar Basa, USAID mechanical engineer, is thoroughly familiar with the AID hand pump and plans on being involved in future production of the pump. Some limited technical assistance from external sources might be advisable to assure adherence to original specifications.

3. Donors and host country organizations other than BWP project personnel are not using the AID hand pump in their rural water supply programs. The largest number of hand pumps, some 10,000 Jetmatics annually, are being manufactured and installed through the Rural Waterworks Development Corporation, a program under the Philippines' Ministry of Human Settlements. While it is felt by this author that the AID hand pump is far superior to the Jetmatic, the Rural Waterworks Development Corporation has not been interested in using the AID hand pump in the

past and shows no inclination to use it in the future. Wisely, the USAID Mission has agreed to push for inclusion of the use of the AID hand pump in programs other than BWP, and this should eventually prove the sturdiness, reliability, and cost-effectiveness of the AID hand pump.

4. The AID hand pump manufacturer, Tri-Star Metal Industries, is not selling hand pumps to the private sector or marketing the pump due to the closing of its foundry and machine shop operations.

5. Communities involved in the AID hand pump field installations, in cooperation with provincial engineers, are able to maintain the pumps. Unfortunately, a systematized procedure for obtaining spare parts has not been worked out yet because of the limited number of pumps in the field and because spare parts have not yet been needed. However, the time will come when spare parts are needed and the USAID Mission is strongly urged to arrange as quickly as possible for at least a minimal inventory of these spare parts at the provincial engineer's offices where AID hand pumps are installed.

6. The BWP personnel originally trained in installation, operation, and maintenance of the AID hand pump are still operationally involved and solid supporters of its use in the BWP.

7. No data is available on the projected prices of the AID hand pumps if additional orders should materialize. However, Mr. Rene Galera, Philippines Valve Manufacturing Company, who was originally involved in the manufacture of the AID hand pump, does not believe the price would significantly increase over the original price of $95.60 (U.S.).

8. There have been two major organizations involved in the AID hand pump technology transfer effort, the USAID Mission and the Philippines Ministry of Local Government through its Barangay Water Program. The USAID Mission is continuing, at a decreased level of involvement, its

role in the overall Barangay Water Program. This includes the use of the locally manufactured AID hand pump. The Ministry of Local Government also is continuing its involvement in promoting the use of the AID hand pump for the Barangay Water Program. While the AID hand pump has not been installed in large numbers in the field, both the USAID Mission and the Ministry of Local Government solidly support the technology transfer effort.

9. Other than the 250 AID hand pumps manufactured under the original technology transfer effort, no AID hand pumps have been produced by Philippine industry. However, BWP personnel are committed to continuing the use of the AID hand pump and plan on placing future orders for its manufacture through competitive bidding.

10. Current USAID Mission staff, Mr. Crowe and Mr. Basa, are keenly aware of the technology transfer and private sector initiatives of the initial pilot program, which is still ongoing. They appear to be committed to seeing that this overall development assistance is a catalyst for longer term impact in BWP, as well as in other Mission-funded programs that relate to health services.

11. The AID hand pump program has gone well in the Philippines. However, the overall technology transfer effort is not finished. Future orders for the AID hand pump will require limited technical assistance to assure adherence to original specifications. Marketing emphasizing the advantages of the AID hand pump over other commercially available or imported hand pumps has been practically nonexistent. In regard to marketing, it is strongly urged that the AID hand pump be promoted for use in other AID health programs and that other development agencies (for instance, the U.S. Peace Corps) be made aware of the effectiveness of AID hand pump programs.

12. Several of the AID hand pumps manufactured in the Philippines and installed in the field have shown a slight wearing of the sliding

blocks. Even though the blocks are inexpensive and easy to change, their life expectancy should be lengthened as much as possible and practical. This can be done by the possible establishment of hardness specifications whereby the blocks are hardened from a material no more than 10-20 points lower on the Rockwell scale than cast iron hardness (which the pump cap is made from).

13. Many developing countries do not have the manufacturing capabilities for producing cast iron products, such as the AID hand pump. Consideration should be given to using the Magsaysay design where the AID hand pump is inappropriate.

TRIP REPORT: INDONESIA

OCTOBER 6-13, 1982

BACKGROUND

At the request of the Government of Indonesia and AID, Georgia Tech personnel travelled to Indonesia in April 1978 to determine the feasibility of manufacturing the AID hand pump in-country. After surveying foundries, machine shops, retail outlets selling hand pumps, and plastic pipe manufacturers and interviewing USAID Mission and Indonesian Government officials involved in existing or planned rural water supply programs, it was determined that adequate market and manufacturing facilities existed to justify an AID hand pump program. In October 1978 the manufacture of 45 AID hand pumps was initiated under Contract ASIA-C-1366. The order was later increased to 60. Completed in March 1979, the pumps were stored for later installation and field monitoring.

Beginnning in late August of 1979, field tests of the manufactured hand pumps were initiated and an additional 170 hand pumps were produced. This second phase involved the following, quoted from Contract No. AS1A-C-1426:

> This program of work will involve the contractor in the field testing of 60 AID hand pumps manufactured in Indonesia under contract ASIA-C-1366 to determine and improve the level of quality of the hand pumps prior to widespread distribution throughout the country. This program will involve preparation of wells, installation of pumps, disinfection of well waters, monitoring of pump performance, analysis of performance data, maintenance and repair of pumps over the life of the monitoring period, training of rural villagers, government representatives and sanitarians in installation and maintenance procedures, and, where pump defects are found, providing technical assistance to the pump manufacturer

until the defects are corrected. This program of work will also include the local manufacture of 170 deep- and shallow-well hand pumps (in addition to the 60 manufactured under contract ASIA-C-1366).

More specifically, Georgia Tech was to perform the following tasks:

1. The coordination of manufacture, quality control, and formal acceptance of 170 deep- and shallow-well hand pumps.

2. The site development and installation of 35 hand pumps, manufactured under contract ASIA-C-1366, in the Bandung area of Indonesia with a 12-month monitoring/evaluation and reporting period during a total project period of 24 months. A PVO, with the backup of the contractor, was to install these 35 hand pumps and keep five shallow- and five deep-well hand pumps as spares. Bacteriological testing of wells before and after installation was to be performed. The PVO was identified as CARE/Indonesia.

3. The site selection, site development and installation of 10 deep-well hand pumps in the Jakarta area of Indonesia for a World Health Organization (WHO)/Ministry of Health (MOH) independent monitoring program which would facilitate acceptance of AID hand pumps for use by the Government of Indonesia (GOI). Five additional hand pumps were to be provided the WHO/MOH monitoring program as spares. All 15 hand pumps used for this activity were to come from those previously manufactured under contract ASIA-C-1366.

4. The site selection, site preparation, supervision, and installation of 10 deep-well hand pumps for each of six USAID Provincial Area Development Program (PDP) project areas (Bengkulu, Kupang, Semarang, Benjarmasin, Surabaya, and Banda

Aceh). Georgia Tech was to ship 120 hand pumps, 10 by air with appropriate materials (drop pipe, plunger rod) and 10 by surface carrier to each of the six provincial areas. The latter 10 to each of the six areas were to be installed by PDP personnel (consultants) with supervision of the contractor (Georgia Tech).

Note: This meant each province would get a total of 20 hand pumps. Georgia Tech was to program at least three trips from the Jakarta area to each respective site for (1) reconnaissance and site selection, (2) installation and (3) follow-up. The PDP personnel were to secure all clearances and exact site approvals before Georgia Tech developed the sites and installed hand pumps by using PDP personnel in the field. These same PDP personnel were also to receive training in pump installation, operation and maintenance, and assist Georgia Tech in hand pump performance monitoring and evaluation. Appropriate Indonesian PDP counterparts were also to receive training in pump installation, operation and maintenance, and assist Georgia Tech in hand pump performance monitoring and evaluation.

5. The area assessment and evaluation of the feasibility of the local manufacture of the AID hand pump in three PDP areas. Georgia Tech was, for this activity, to program manpower to work with local foundry/machine shops to upgrade their capabilities.

6. The provision of three AID hand pumps out of the 170 to be manufactured under activity item 1 to each of 11 sites for sanitation schools as training aids. Georgia Tech was to budget manpower, transport and travel to develop one well and install one hand pump at each of the 11 school sites in Indonesia. Two additional hand pumps were to be surface

shipped to the schools for teardown demonstration and training models for the students.

Note: The 11 sites were to receive a total of 33 hand pumps. The 11 sites were as follows:

| | |
|---|---|
| Medan | Lampung |
| Purwokerto | Bandung |
| Denpasar | Surabaya (two schools) |
| Ujung Pandang | Benjarmasin |
| Jakarta | Manado |

7. Provide administrative and managerial functions connected with this program.

PROGRAM STATUS

In early 1981 available funds were depleted and expected additional funds had failed to materialize. Georgia Tech's involvement in the Indonesian AID hand pump program then ended. The following is a summary of the status of the project as of April 29, 1981.

CARE/Bandung. The 35 test sites in Bandung had been in operation almost one year since the completion of the installation program in early June of 1980. Tasks there included both the training of local counterparts in the installation and maintenance of the AID hand pump and the establishment of and the training of local personnel for the operation of a field-based, water quality analysis laboratory. The success of this portion of the project was highlighted by the additional installation of some 250 AID hand pumps by CARE under an independently funded project. All AID test pumps were in good working order with no difficulties anticipated in their future maintenance and repair.

WHO/Jakarta. The World Health Organization (WHO) included the installation and monitoring of 10 AID hand pumps in their continuing hand pump evaluation program in Indonesia. Installed at test sites on the outskirts of Jakarta and monitored by WHO technical staff, these pumps were put into operation in mid-1980. A formal report indicating a favorable review by WHO performance criteria was released in February 1981.

PDP Program. The PDP program contractually called for the installation of 20 AID hand pumps in each of the PDP (Provincial Development Program) areas of Aceh, Bengkulu, Benjarmasin, Semarang, Surabaya, and Nusa Tenggara Timor (Kupang) using PDP and Indonesian Government counterpart personnel. A summary of progress by province follows.

## Aceh

Of the PDP areas, Aceh was by far the most productive. Six sites were selected for hand pump installation at Aceh Besar. Due to difficulties in getting four wells at Aceh Barat reconditioned in preparation for pump installation, plans were made for these four sites and the remaining 10 to be relocated to Aceh Besar. Counterpart personnel were agreeable to the relocation and later prepared the wells and installed the pumps themselves, having been trained in installation and maintenance procedures during the installation of the six pumps at Aceh Besar.

## Semarang

Seven pumps were installed in Semarang. Due to an overall shortage of existing wells, only one pump was installed before a local driller had to be contracted. Of 11 boreholes drilled, six produced water and subsequently had pumps installed. Termination of further work was required because of the lack of available water-producing sites.

## Nusa Tenggara Timor (Kupang)

All sites in Timor would have required the drilling of new wells. However, due to continuing civil disturbances and the medical evacuation of a local AID consultant, work was never initiated.

## Surabaya-Bengkulu-Benjarmasin

Twenty wells were drilled in Surabaya, with 12 producing water. All twelve were in the process of having pumps installed when the project ended. In Bengkulu, a preliminary visit for site selection revealed test sites would require drilling. This was not initiated because of prohibitive costs and low rates of water-producing wells experienced in Semarang and Surabaya. No work was initiated in Benjarmasin due to the difficulties encountered in the other PDP areas and because expected funding to continue the project was not available.

RSMD Program. The Rural Sanitation Manpower Development (RSMD) portion of this project was to have had one pump installed by staff and students at each of eleven sanitarian schools. Because of numerous and various delays in construction of school buildings and the accompanying delay in getting the school's academic programs underway, no work was initiated by Georgia Tech personnel. However, preliminary discussions and potential site surveys revealed an ideally wide range of suitable sites.

P. T. Celco. At the conclusion of the project P. T. Celco of Bandung was the sole manufacturer of the AID hand pump in Indonesia. In addition to supplying all pumps for the Georgia Tech project, P. T. Celco produced approximately 250 pumps for CARE. The company had also scheduled production of 2,000 pumps to be installed as part of an Asian Development Bank rural water supply project in Sulawesi when the project was terminated.

TRIP ACTIVITIES

Wednesday, October 6. Garuda flight 937 was taken from Manila to Jakarta, Indonesia where both Mr. Hofkes and I checked into the Sahid Jaya Hotel. Mr. McJunkin and Mr. Donaldson did not participate in this country's technical/management review because of the USAID Mission's hectic schedule and a desire to keep the review team as small as possible.

Thursday, October 7. The morning was spent meeting with Mr. Ellis Franklin, CARE Director/Indonesia. Mr. Franklin reported that the AID hand pump program was going extremely well in Indonesia where CARE was involved. He stated that it would continue indefinitely, particularly if the USAID Mission continues to co-finance some of the costs with CARE. Mr. Franklin further reported that CARE had purchased close to 1,000 pumps (AID design) which have been installed in the Bandung (Java) and Lombok Island areas. Field trips by Mr. Franklin to these two areas have shown a favorable level of acceptance by pump users and a strong willingness by villagers to participate in maintenance and repair. In regard to maintenance and repair, villagers routinely come to CARE offices to purchase spare parts when their inventory levels get too low. Requests from villagers for pumps exceed CARE resources (money, time and personnel) for meeting the requests.

In the afternoon, Mr. Hofkes and I went to the United Nations building to see if we could get an idea of the overall rural water supply programs now underway or being planned for Indonesia. Most of the appropriate personnel (such as people from UNDP, UNICEF, WHO) were unavailable. We did meet with Dr. W. L. Reyes, WHO sanitary engineer, who suggested that some 500,000 hand pumps are now needed to meet the needs of Indonesia's rural citizens. The Indonesian Government is convinced that these hand pumps must be locally manufactured, and maintenance and repair is a problem which is being closely studied by the Government. A solution most likely will include participation by village caretakers. A preliminary conclusion is that Dr. Reyes should study the CARE program if a field trip to Bandung reveals it to be as effective as Mr. Franklin has told us.

Friday, October 8. Mr. Hofkes and I took a seven o'clock air shuttle to Bandung in the early morning. We were met at the airport by the head of the Bandung office, Mr. Donna Krisna. All three of us then proceeded to 10 sites near Bandung where hand pumps were installed in early 1980. Observations included:

1. Babakan Cibaduyot (pump installed March 8, 1980):

   - Several people were waiting to use the pump.
   - All 300 people (100% of the village) reported daily use of the pump.
   - The pump (deep-well model) operated very easily over a well 32 meters deep (static water level unknown).
   - The pump was well lubricated and functioning properly.
   - One fulcrum pin (located at the handle fulcrum/handle intersect) was slightly worn, but not badly.
   - Drainage from the site was good, with waste water being piped underground 42 meters away from the pump site.

2. Blok Pesantren (pump installed February 23, 1980):

   - Six women and small children were waiting to use the pump.
   - Approximately 200 people were reported to use the pump daily.
   - The pump (deep-well model) operated very easily over a well 32 meters deep (static water level unknown).
   - The pump was well lubricated and functioning properly.
   - Drainage from the site was good, with waste water being piped underground 30 meters away from the pump site.

3. Dayeuh Kolot Cibaduyut (pump installed April 28, 1980):

- o Three women were waiting to use the pump.
- o Daily use (from 4 a.m. to 8 p.m.) of the pump was reportedly 500 people.
- o The pump (deep-well model) operated very easily over a well 50 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly even though one bushing was missing.
- o Drainage from the site was good, with waste water being piped underground 35 meters away from the pump site.

4. Blok Sepatu (pump installed May 9, 1980):

- o Four women were waiting to use the pump.
- o Reportedly, 200 people use the pump daily.
- o The pump (deep-well model) operated very easily over a well 30 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly even though three bushings were missing.
- o Drainage from the site was good, with waste water being piped underground 20 meters away from the pump site; however, an open dug well has been constructed approximately five meters from the site where the pump is installed.

5. Blok Situ (pump installed May 5, 1980):

- o Four women were waiting to use the pump.
- o Approximately 200 people reportedly use the pump daily.
- o The pump (shallow-well model) operated very easily over a well 37 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly. Disassembly of the pump showed no wear of pins or bushings.
- o Drainage from the site was good, with waste water being piped underground 12 meters away from the pump site.

6. Cijaura Sekejait No. II (pump installed April 14, 1980):

- o Fifty people reportedly use the pump daily.
- o The pump (shallow-well model) operated very easily over a well 40 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly.
- o Drainage from the site was good, with waste water being piped underground away from the pump site (distance unknown).

7. Cijaura Sekejat No. I (same village as above, with pump installed March 29, 1980):

- o Reportedly, the pump is used daily by 150 people.
- o The pump (shallow-well model) operated very easily over a well 30 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly even though one bushing was missing.
- o Drainage from the site was good, with the waste water being piped underground away from the pump site (distance unknown).

8. Babakan Jati No. II (pump installed April 4, 1980):

- o Four women were waiting to use the pump.
- o At least 1,000 people reportedly use the pump daily (from 3 a.m. to 10 p.m.), because other wells in the area are dry.
- o The pump (deep-well model) operated very easily over a well 33 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly.
- o Drainage from the site was good, with the waste water being piped underground away from the pump site (distance unknown).

9. Babakan Jati No. I (pump installed April 19, 1980):

- o From 3 a.m. to 8 p.m. daily, 800 people reportedly use the pump.
- o The pump (deep-well model) operated very easily over a well 40 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly, even though one bushing was missing.
- o Drainage from the site was good, with the waste water being piped underground away from the pump site (distance unknown).

10. Babakan Jati No. 3 (pump installed April 11, 1980):

- o Reportedly, the pump is used daily by 100 people.
- o The pump (deep-well model) operated very easily over a well 39 meters deep (static water level unknown).
- o The pump was well lubricated and functioning properly except that the foot valve leaked badly.
- o Drainage from the site was good, with the waste water being piped underground away from the pump site (distance unknown).

Drainage of the pump's waste water away from the sites by underground piping seems very effective. However, areas around the sites appeared very unsanitary, with open ditches of foul-smelling drainage water, accumulated garbage, and human feces visible.

Despite several pumps with missing bushings and one pump with a leaking leather flapper foot valve, the obvious care being given the pumps by the villagers has been impressive. All pumps were well lubricated and showed negligible, if any, wear after 2 1/2 years of unusually heavy usage. As in Sri Lanka and the Philippines, pins and bushings appear to be holding up well. The villagers were very receptive and cordial, allowed us to visit

the pump sites and openly expressed their satisfaction with the pumps. Unfortunately, the manufacturer did not do a good job of press fitting the bushings, and the spare parts kits left with the villagers failed to include bushings. Overall, CARE has done an excellent job here in establishing village interest and participation if these 10 sites are representative of the total.

After visiting the above sites, Mr. Hofkes, Mr. Krisna and I went to the AID hand pump manufacturer's plant. Mr. Tano Tjakrasasmita, owner and manager of P. T. Celco, was in Jakarta at the time which prevented a highly desirable personal interview with him. Administrative personnel in the office, however, were able to give us the following list of hand pump orders received since the initial Georgia Tech pilot program:

| | |
|---|---|
| 500 | CARE/Bandung |
| 200 | CARE/Lombok |
| 3,161 | Asian Development Bank for Kemdiri, Sulawesi |
| 50 | by a transmigration group for Jambi, Sumatra |
| 300 | by the Indonesian presidential office's IMPRES program for Cirrebon, Java |
| 4,211 | Total |

Prices of the pumps have increased from $50 (U.S.) to $77 for the shallow-well model and from $60 to $92 for the deep-well model during the last three years.

The 3,161 hand pumps ordered by the Asian Development Bank were still being produced in the plant. Castings observed sometimes contained voids, fulcrum pins were not hardened to original specifications, and hardened bushings had been eliminated for the Asian Development Bank order. For unknown reasons, a stuffing box in the pump cap was included, perhaps to keep external sources of water from entering the pump. Of great concern was the fact that the wall thickness of the pump base castings had been

reduced by what appeared to be at least 50 percent. In questioning the P. T. Celco staff as to why fulcrum pins were not being hardened, why bushings had been eliminated, why the stuffing box had been added, and why the wall thickness of the castings had been reduced, the answer given was that this was what the Asian Development Bank had specified.

Saturday, October 9. Mr. Hofkes and I, accompanied by Mr. Krisna, went to the Ministry of Industry's Metal Industries Development Centre (MIDC) and met with a Mr. Abdurahim, head of the foundry section. MIDC is a government agency that appears to be doing an excellent job of providing specialized technical assistance to foundries and machine shops throughout Indonesia. It also had provided wooden patterns and jigs and fixtures to P. T. Celco for Georgia Tech's pilot AID hand pump manufacturing program.

Mr. Abdurahim explained to us that MIDC has made quite a bit of progress in establishing formal standards for foundries and machine shops in Indonesia producing the Bandung and Dragon hand pumps. Mr. Abdurahim also showed us preliminary design drawings for a deep-well version of the Bandung pump. This design includes the original cap of the AID shallow-well hand pump, which was discarded due to its fixed fulcrum and a tendency to break even under good casting conditions.

Before leaving MIDC, I discussed with Mr. Abdurahim the possibility of P. T. Celco's contracting with MIDC to establish a quality control program. This would involve MIDC drawing up formal specifications and conducting random inspections of finished pumps, including metallurgical analysis. Mr. Abdurahim was agreeable; however, I doubt that P. T. Celco would pay for MIDC services.

From MIDC we met with the Dutch consultant contracted for the West Java Rural Water Supply Project. This project has included the development of water points using hand pumps up to fairly large, sophisticated piped systems with disinfection. For sites where hand pumps were appropriate the Bandung pump has been installed and, in fact, it was developed under the West Java Rural Water Supply Project. The Bandung pump, incidentally, has

the lower portion of the Dragon pump and the upper portion (from the spout up) of the original AID shallow-well pump with the fixed fulcrum cap. The lower portion of the Dragon pump was used in its design because of certain parts (piston assembly, foot valve and rubber cup seals) being readily available at almost all hardware stores in Indonesia.

The meeting with the West Java Water Supply Project consultants was interesting, but provided no clear information concerning the merits of the Bandung pump. Mr. Ben van Bronckhorst, the project manager, was extremely negative about hand pumps (including the Bandung pump) because the villagers would not keep them repaired. Surprisingly, he feels that too many hand pumps in rural areas will destroy the balance of good water to that which is brackish from salt water intrusion. Mr. Ron van Kerkvoorden, the deputy team leader, on the other hand, felt that the Bandung pump was performing especially well, that villagers were maintaining the Bandung pump, and that hand pumps posed no threat to the groundwater balance.

Before catching an afternoon flight back to Jakarta, we stopped at the CARE office. CARE is continuing to use the bacteriological and chemical test equipment left by Georgia Tech, but a refresher course is necessary since nearly three years have elapsed from the time of initial training. CARE is also continuing to leave a set of tools and spare parts with the village chief where any AID hand pump is installed, with each set delivered in a very nice wooden box with a hinged top and a padlock. The spare parts kit contains the following (as noted earlier, no bushings are provided):

- 3 plunger rods
- 4 piston assemblies
- 10 leather cups
- 4 couplings
- 2 rod ends
- 1 set fulcrum pins
- 4 sliding blocks
- 5 rolls Teflon pipe joint sealing tape
- an assortment of cotter pins, nuts, bolts, screws

The tool kit contains the following:

- o 2 1/2" to 4" adjustable pipe wrenches
- o 2 1/2" to 2" adjustable pipe wrenches
- o 1 10" crescent wrench
- o 1 hammer
- o 1 10" vise grip
- o 1 screwdriver
- o 1 set of pliers
- o 1 punch

A set of working drawings of the AID hand pump was left with CARE after discussing each drawing in detail. Mr. Krisna promised to take the drawings to P. T. Celco on Monday, October 11, and emphasize the importance of hardened pins and bushings (press fitted) as well as the danger of reducing the wall thickness of the castings. While driving to the airport I congratulated Mr. Krisna for what I consider to be an excellent program by CARE/Bandung. Mr. Krisna, in turn, mentioned that our visit was timely because he had forgotten a lot of important details during the last several years. It now appears important that a follow-up visit be made in the next several months when there is sufficient time to spend with the pump manufacturer on quality control and with CARE on water quality analysis, hand pump installation, and hand pump maintenance and repair. Such a visit would improve this effective, ongoing program which shows tremendous potential and might be the basis for a case study on effective village participation in rural water supply programs.

Sunday, October 10. Today was spent in the hotel writing this report.

Monday, October 11. Today was a U.S. holiday and the embassy was closed. I was, however, able to talk by telephone with the USAID health officer, Dr. David Calder, and relay my findings of the last several days. The rest of the day was spent writing this report and making plans for my departure to the U.S. tomorrow.

Tuesday, October 12. Cathay Pacific flight 710 was taken from Jakarta to Hong Kong.

Wednesday, October 13. Pan Am flight 6 was taken from Hong Kong to San Francisco. Delta flight 1126 then was taken to Atlanta.

## CONCLUSIONS AND RECOMMENDATIONS

1. All pumps (10) inspected during this trip were functioning even though one (Babakan Jati No. 3) had a badly leaking foot valve. CARE/Bandung personnel promised to return to Babakan Jati No. 3 within two weeks and at that time repair the pump if the villagers had not already done so. The 10 pumps inspected and found to be functioning were very close to Bandung, however, and more than likely have received the most attention during the past several years. If time had permitted, it would have been very desirable to have visited the more distant sites where some 400-500 pumps are installed to observe the level of maintenance and repair interest and capabilities.

2. The original manufacturer of the AID hand pump in Indonesia, P. T. Celco, is still producing the AID hand pump and in sizeable quantities. P. T. Celco is not adhering to manufacturing specifications established during the AID hand pump pilot program. An Asian Development Bank order for 3,161 pumps now being produced does not contain bushings for fulcrum pins; fulcrum pin stock is not further hardened to 40-45 $R_C$; and the wall thickness of the castings has been drastically reduced. It is highly recommended that short-term technical assistance be provided to P. T. Celco as soon as possible for the purpose of convincing management of the dangers of deviating from specifications that have been determined to be valid and sound in other countries. From this technical assistance, P. T. Celco hopefully would enter into a contractual arrangement with Metal Industries Development Centre for the establishment of formal standards, inspections, and certification to the standards.

3. Other donors and host country organizations are using the AID hand pump design and the manufacturer, P. T. Celco, introduced during the pilot program of establishing AID hand pump manufacturing capabilities into Indonesia.

4. The manufacturer is not selling AID hand pumps to the private sector in appreciable quantities. Occasionally, representatives from communities near the Bandung area come to the manufacturer, or more often to CARE, to purchase a pump or spare parts, but not on a large-scale basis.

5. Communities involved in the pilot program are not only able to maintain their hand pumps, they are doing this very well. All pumps observed during the trip described herein were well lubricated and working even though several had missing bushings and one pump had a defective foot valve. Tools earlier issued to community leaders were still in place and reserved for specific use in maintaining and repairing the hand pumps.

6. CARE and its personnel originally trained in installation, operation, maintenance, and repair of the AID hand pump and in water quality analysis are still operationally involved in an ongoing AID hand pump program. Not only is CARE doing an excellent job in continuing the program in the Bandung area, it has expanded the program to Lombok. Both CARE and the USAID Mission should be congratulated for their diligence in this endeavor.

7. The price of the AID hand pump has increased from $50 to $77 for the shallow-well model and from $60 to $92 for the deep-well model during the last three years. Considering the effects of inflation on coke and scrap iron in the world market during this time period, P. T. Celco evidently has not exploited a market where it is producing one of the better, if not the best, pumps in Indonesia. Of considerable importance is that the AID hand pump is still one of the few deep-well pumps available as a locally manufactured product.

8. Due to time constraints and a hectic schedule made by USAID Mission personnel, it was not possible to determine the present overall involvement and awareness of various parties (USAID, WHO, UNDP, the Indonesian Government) in a continuing technology transfer effort with the AID hand pump. However, the level of activity by P. T. Celco seems to give evidence that the initial technology transfer effort has had considerable impact. CARE alone has purchased 700 pumps and another 3,511 have been purchased by the Asian Development Bank and the Government of Indonesia.

9. It has been a pleasant surprise to experience the positive results of the AID hand pump program in Indonesia which ended so prematurely due to a lack of available funding. Not only is private enterprise working, but it is at the same time, proving the soundness of the concepts in the AID hand pump program. It seems appropriate that AID/Washington and/or the USAID Mission in Indonesia should further investigate this successful example of technology transfer and disseminate their findings for inclusion in other, similar efforts.

TRIP REPORT: HONDURAS

JANUARY 17-22, 1983

## BACKGROUND

In January 1981, a telegram was sent from the U.S. Embassy in Tegucigalpa to Mr. Victor Wehman of AID/Washington requesting that a project be initiated in Honduras and funded to "develop local capability to fabricate hand pumps and well screens." The telegram was based on a feasibility study carried out in August 1980 which showed that local manufacture of the AID hand pump and the Roboscreen was feasible and on the fact that the AID hand pump could be used in rural Honduran environmental sanitation outreach programs.

The broad goals of the project required developing in Honduras the production capability of the AID-designed hand pump and the Roboscreen, and establishing good working relationships with counterpart organizations in Honduras such as the USAID Mission, the Honduran Ministry of Health and the Honduran National Water and Sewer Authority. More specifically, the project was to help the Government of Honduras under its five-year plan, 1979-1983, to provide easy access to safer water through community wells for 75 percent of the rural population and to provide some form of human waste disposal system for 38 percent. Given present coverage and population growth, these goals imply a target group of 1,200,000 for new water and sanitation systems, with an additional 170,000 needing repaired water systems during this period. Obviously, it is considered highly desirable for such a program to obtain as much as possible of the hardware (for instance, hand-operated water pumps) within the country not only to facilitate the logistics of supply, but ultimately to stimulate the economy of the Honduran manufacturing sector.

Rural Water and Sanitation Project (PRASAR). The Rural Water and Sanitation Project, or PRASAR, is a USAID/Honduras loan-funded project

designed to provide 180 aqueducts, 21 sewer systems, 18,000 water-sealed latrines, 10,000 pit latrines, improvement of 80 existing aqueducts, and installation of 3,000 hand pumps. The project also has a health education component to provide training to health promoters and produce sanitation promotional material. This integrated effort is being carried out by two government agencies, The Ministry of Health and the National Water and Sewer Authority. The project was initiated in October 1980 with a completion date of October 1983.

Unfortunately, due to a change of government in 1982, lack of government counterpart funds and complex government procurement procedures, severe logistical problems developed that resulted in a delay of project goals. USAID and PRASAR now are considering reducing the project goals and extending the date of completion. For example, the goal of installing 3,000 hand pumps may be reduced to the number of Dempster hand pumps presently installed (135) plus the number of hand pumps (1200) ordered at the beginning of the project and still in inventory in Honduran warehouses (1065). It had been planned at the beginning of the project to use the Dempster hand pumps while the manufacturing capability for producing AID hand pumps and Roboscreen was being developed, then to switch to AID hand pumps as the Dempster inventory became depleted. Thus, the market for AID hand pumps appears to be diminishing unless other areas of Honduras (outside the PRASAR project area) accept and adopt it for use, a matter that USAID Mission personnel are pursuing.

## TRIP ACTIVITIES

Saturday, January 15. Mr. Ebbo Hofkes was met at the Atlanta airport upon his arrival from Amsterdam and transported to the Howard Johnson Motel on 10th Street and Interstate 75.

Sunday, January 16. Mr. Hofkes and I met Messrs. McJunkin and Donaldson at the Atlanta airport upon their arrival from Washington and transported them to the Howard Johnson Motel for registration. We then proceeded to the

Georgia Tech hand pump testing facility (see Figure 7) for an inspection of the facility and a review of results from testing pumps (all AID models) from the Philippines, Honduras, Haiti, Dominican Republic, Tunisia and Ecuador. A progress report (see Attachment 2) was distributed which had been prepared by Georgia Tech's Dr. B. S. Dixit for the technical/management review team visit. Not covered in Dr. Dixit's report is the fact that a weighting is being determined for each pump based on casting quality (derived from dimensional measurements and subjective judgment of casting smoothness, voids and inclusions), machining quality (based on dimensional measurements and subjective judgment of threading, hole alignment between connecting components, etc.), and test performance data (based on dimensional measurements of pump components during scheduled inspections for wear during testing, frequency of pump failures during testing, and seriousness of pump failures, if any, during testing). Since none of the pumps have finished a required 10 million cycles of operation, performance data is still incomplete. However, present indications are that the respective pumps will be ranked somewhat in the following order:

1. Philippines (shallow-well and deep-well models)--These pumps appear to be "excellent" in casting, machining and performance.

2. Honduras (shallow-well and deep-well models)--These pumps appear to be "very good." They would be rated "excellent" if not for a leather flapper-type foot valve and some less than desirable machining done without the use of jigs and fixtures.

3. Ecuador (deep-well model)--This pump appears to be "good." It would be rated as "very good" if not for a leather flapper-type foot valve and some less than desirable machining due to poor quality control.

4. Tunisia (modified deep-well model)--This pump has been determined to be "poor and unacceptable." It has machining deficiencies; but its most significant fault is its PVC drop pipe arrangement that serves also as the pump cylinder. It has a tendency for PVC separation at the pipe joints.

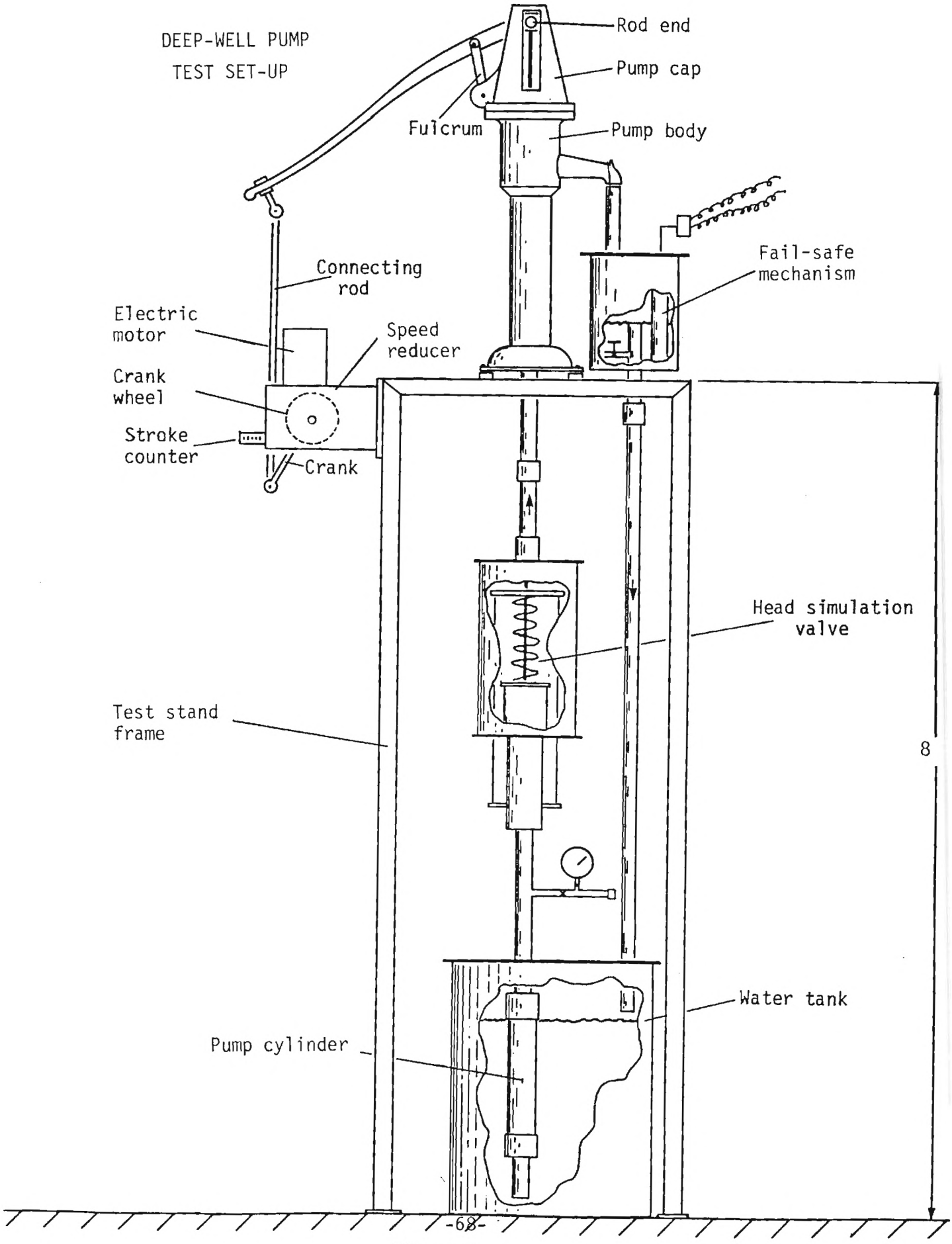
DEEP-WELL PUMP
TEST SET-UP
Rod end
Pump cap
Fulcrum
Pump body
Fail-safe mechanism
Connecting rod
Electric motor
Speed reducer
Crank wheel
Stroke counter
Crank
Head simulation valve
Test stand frame
8
Water tank
Pump cylinder



Figure 7.

5. Dominican Republic (shallow-well and deep-well models)--These pumps have been determined to be "poor and unacceptable." They have considerable casting voids and machining deficiencies such as poor threading, loose bushings, bushings and fulcrum pins that do not come close to specifications (bushings that are hardened to 4 $R_C$ instead of 60-65 $R_C$, pins that are hardened to 55 $R_C$ instead of 40-45 $R_C$), leather flapper-type foot valves that do not fully cover the foot valve seat, and poor interchangeability of components.

6. Haiti (deep-well model)--This pump has been determined to be "poor and unacceptable." It has extremely poor casting and machining quality that led to the termination of testing after only 150,000 cycles of testing.

Monday, January 17. Messrs. McJunkin, Donaldson, Hofkes and I, along with Georgia Tech's Dr. Henry Van, took Delta flight 1131 from Atlanta to Miami. From Miami to San Pedro Sula, Honduras, Air Florida flight 475 was taken. Upon arrival at the Gran Sula Hotel we were met by Mr. Porfirio Sanchez, Georgia Tech's Honduran counterpart from the Central American Research Institute for Industry (ICAITI). ICAITI has been collaborating with Georgia Tech on Latin American AID hand pump programs since 1976 because its personnel are fluent in Spanish, know the Latin American culture and government agencies which must be dealt with, and pursue the same development goals as Georgia Tech.

Tuesday, January 18. Messrs. McJunkin, Donaldson, Hofkes, Van, Sanchez and I, accompanied by Mr. Efrain Giron of the Honduran Ministry of Health, travelled to La Lima this morning to inspect hand pump installations. La Lima is a fairly large community located parallel to the San Pedro Sula airport. Parts of La Lima have piped water and parts have no readily accessible water supply, and it is situated on very flat land that makes drainage almost impossible. Most of the pumps in La Lima are installed on old, driven wells even though some are installed on newly drilled wells. Observations of the installations were as follows:

1. Marcela Escalante--One AID shallow-well pump installed July 18, 1982 was examined. It was working well. Even though heavily used, the foot valve was holding well. Sliding blocks, however, were beginning to show some wear. The pump was well lubricated.

2. Mabel Maria Escobar--One AID shallow-well pump installed April 16, 1982 was examined. It was not working because of what appeared to be a defective foot valve. The pump base also was somewhat loose from its anchored position in the concrete upperstructure.

3. Clemente Ortiz--One AID shallow-well pump installed March 22, 1982 was examined. It was working well. Even though heavily used, the foot valve was holding well. The pump was well lubricated.

4. Rutilia Hernandez--One AID shallow-well pump installed April 18, 1982 was examined. It was working well. The foot valve was holding well. The pump was well lubricated.

5. Ambrosio Ramos--One Dempster 210F installed July 17, 1982 was examined. It was working well and properly lubricated.

6. Thomas Rivera--One AID shallow-well pump installed March 28, 1982 was examined. It was working well, its foot valve was holding, and it was well lubricated.

7. Antonio Portillo--One Dempster 210F installed October, 7, 1982 was examined. It was working well and properly lubricated.

8. Blanca Lidia Barahona--One AID shallow-well pump installed April 16, 1982 was examined. It was working well, its foot valve was holding, and it was well lubricated.

9. Teodora Osorio--One AID shallow-well pump installed April 19, 1982 was examined. It was working well and its foot valve was holding. It was

somewhat lacking in lubrication as there was only a slight film of grease on the moving components. The grease was old and had begun to dry.

10. Paula Morales--One AID shallow-well pump installed July 12, 1982 was examined. It was working well, its foot valve was holding, but it needed lubrication.

11. Francisco Osorto--One AID shallow-well pump was examined (installation date unknown). It was working well and properly lubricated. Its foot valve was holding.

In the afternoon we travelled to Travesia and Bajamar to inspect hand pump installations. These two communities are located by the ocean and are inhabited mostly by fishermen. Observations of the two areas were as follows:

## Travesia

1. Froylan Lamber--One AID shallow-well pump installed May 1, 1982 was examined. It was working well, its foot valve was holding, but it needed lubrication.

2. Alberto Lamber--One Dempster 210F was examined which was installed August 9, 1982. It was working well and properly lubricated.

3. Norberto Morales--One AID shallow-well pump installed June 29, 1982 was examined. It was working well, its foot valve was holding and it was well lubricated.

4. Luis Moreira--One AID shallow-well pump installed April 26, 1982 was examined. It was working well, its foot valve was holding, but it needed lubrication.

5. Valentin Arzu--One Dempster 210F installed August 2, 1982 was examined. It was working well and properly lubricated.

6. Chifia--One AID shallow-well pump installed July 8, 1982 was examined. It was working well, its foot valve was holding, but it needed lubrication.

Bajamar

1. Pedro Reyes--One AID shallow-well pump installed April 19, 1982 was examined. It was working well, its foot valve was holding, and it was properly lubricated.

2. Eustacio Tomas--One Dempster 210F installed June 23, 1982 was examined. It was working well and properly lubricated.

3. Cecelia de Fernandez--One AID shallow-well pump installed April 21, 1982 was examined. It was working well, but needed lubrication.

4. Carmela Saravia--One AID shallow-well pump installed March 19, 1982 was examined. It was working well, its foot valve was holding, and it was properly lubricated.

Wednesday, January 19. Messrs. McJunkin, Donaldson, Hofkes, Van, Sanchez and I, again accompanied by Mr. Efrain Giron of the Honduran Ministry of Health, visited the foundry (FUNYMAQ) where the AID hand pumps have been manufactured. Mr. Mata, the owner of the foundry, gave us an extended tour of his storeroom where he keeps the pump's patterns, jigs and fixtures. After seeing the rest of the foundry and its operations we had an in-depth discussion on possible foot valve design changes. Unfortunately, because we could not agree on the way to retrofit the foot valves already installed in the field, the actual need for a design change on the valves, and the approach to the design change, it was decided to leave the foot valve as it

is (leather flapper type). It is this author's opinion that it is extremely irresponsible to wind up the Honduran project without changing the leather flapper valves to something more durable.

In the afternoon we travelled to an area east of San Pedro Sula to look at latrines with Mr. Giron. The water-sealed and vented latrines were part of the PRASAR project. In general, the latrines looked very good and the villagers seemed to be proud of them.

Thursday, January 20. Messrs. McJunkin, Donaldson, Hofkes, Van, Sanchez and I, again accompanied by Mr. Giron, travelled to Comayagua this morning (on our way to Tegucigalpa) to see hand pump installations. Observations of the Comayagua area were as follows:

1. San Jose (Villa San Antonio)--One AID deep-well pump installed May 13, 1982 was examined. It was working well, it was properly lubricated, but three strokes were required before water flowed from the pump's spout.

2. Carreterra (frente aldeas sos)--One AID deep-well pump installed May 28, 1982 was examined. It was working well, it was properly lubricated, but six strokes were required before water flowed from the pump's spout. The site needs steps to the platform of the well and the pump needs to be repositioned (Dr. Van will take care of these matters next week).

3. San Nicolas (Campo Balompie)--One AID deep-well pump and one Dempster 210F, both installed May 24, 1982 were examined. The Dempster was working well and properly lubricated. The AID pump was properly lubricated but not working. Reportedly it was not working because its cylinder had not been installed as deeply as that of the Dempster, and a truck had come by earlier and filled several drums of water. This temporarily drew the well's water level down below the pump's cylinder. The site needs steps to the well's platform (Dr. Van will take care of this matter next week).

4. San Nicolas (abajo)--One AID deep-well pump and one Sanpar, both installed May 25, 1982 were examined. The AID pump was working well, its foot valve was holding, and it was properly lubricated. The Sanpar was working well, it was fairly well lubricated, but its base was loose in the well's platform (Dr. Van will take care of this matter next week).

5. San Nicolas (escuela)--One AID deep-well pump installed May 25, 1982 was examined. The pump was working well, its foot valve was holding, and it was well lubricated. The site needs steps to the well's platform (Dr. Van will take care of this matter next week).

6. Escuela Palmeiola--One AID deep-well pump and one Sanpar, both installed May 27, 1982, were examined. The AID pump required numerous strokes before water flowed from its spout. This is an indication of a defective foot valve. The AID pump was well lubricated. The Sanpar was working well and was properly lubricated. The site needs steps to the well's platform (Dr. Van will take care of this matter next week).

Friday, January 21. Messrs. McJunkin, Donaldson, Hofkes, Van and I met with Mr. Richard Dudley, USAID/Honduras, this morning to discuss what had been seen at La Lima, Travesia, Bajamar, and Comayagua. Of significance is the fact that 30 hand pumps have been examined during the past several days. Of these 30 pumps, one AID shallow-well model at La Lima (Mabel Maria Escobar site) was inoperable because of a possibly defective foot valve (leather flapper type), and one AID deep-well model at Comayagua (San Nicolas--Campo Balompie site) was inoperable because of a temporary low water level of the well. In addition, there were several AID deep-well models in the Comayagua area that were operational but had leaking foot valves (leather flapper type). All other pumps were in good condition.

As noted earlier, it was decided not to modify and retrofit the leather foot valves that are in the Honduran-manufactured AID (FUNYMAQ) hand pumps. However, Dr. Van will attach auxiliary foot valves to the deep-well models

in the Comayagua area. These auxiliary foot valves are commercially available, cost approximately $8.00 each, and are manufactured by Clayton Mark in the U.S. Dr. Van also will correct noted deficiencies of several sites in the Comayagua area (add steps, reposition pumps, etc.).

Saturday, January 22. Air Florida flight 476 was taken from Tegucigalpa to Miami to conclude the AID hand pump review in Honduras.

## CONCLUSIONS AND RECOMMENDATIONS

1. The AID (FUNYMAQ) hand pumps are, in general, functioning at test sites. Of 30 pumps examined during the management/technical review team's visit to Honduras, only two pumps were not functioning. One of the pumps, at La Lima (Mabel Maria Escobar site), was inoperable because of what appeared to be a defective foot valve. The other inoperative pump, at Comayagua (San Nicolas--Campo Balompie site), was over a well that was heavily used and the water level of the well had temporarily dropped below the location of the pump's cylinder. Most of the test pumps were properly lubricated and in good condition. However, several AID (FUNYMAQ) deep-well pumps in the Comayagua area, while functioning, had varying degrees of leakage at the pump's foot valve.

   It is strongly recommended that a foot valve design used with the AID hand pumps manufactured in the Philippines or one of equal (or greater) durability be manufactured in Honduras and retrofitted to the hand pumps already manufactured.

2. The Honduran AID hand pump manufacturer has not deviated from the original specifications provided at the beginning of the pilot program.

3. Other donors or host country organizations are not using the AID hand pump design and the manufacturer sponsored by AID technical assistance. However, the USAID/Honduras Mission is pursuing alternative markets for

the manufacturer since the PRASAR project is behind schedule and most likely will not advance to the point where AID (FUNYMAQ) hand pumps are needed.

4. The AID hand pump manufacturer, FUNYMAQ, is not selling to the private sector and it does not appear FUNYMAQ will develop an effective marketing program in the near future. Serving the private sector requires at least limited speculative production for display and sale in hardware stores, trade shows, etc. As a developing country small-scale industry, FUNYMAQ does not have the resources for such an investment which also has a certain amount of risk. Instead, FUNYMAQ looks to the government sector for future sales.

5. Communities involved in the field installation pilot program are able to obtain locally manufactured spare parts and maintain the AID test pumps through village caretakers providing basic maintenance and repair, and provincial Ministry of Health engineers and health promoters providing the more complicated maintenance and repair. Because of the close proximity of the manufacturer, FUNYMAQ, to the test sites and the involvement of the manufacturer in the overall project, not just the manufacturing process, USAID and Honduran government personnel are completely familiar with the manufacturer and its location for spare parts or for feedback of information if pump problems should arise.

6. The organization (Ministry of Health) and individuals (provincial engineers, health promoters and village caretakers) trained in installation, operation and maintenance of the AID hand pump are still operationally involved in AID hand pump activities through the PRASAR project.

7. Pricing of the AID hand pump has not changed since the initial order priced at $100 per pump. This is because there have been no subsequent orders as of yet. However, the manufacturer, FUNYMAQ, feels that if future orders should materialize, the AID hand pump will cost between $200 and $250 per unit.

8. The USAID Mission, the host country government through the Ministry of Health, and the manufacturer have been deeply involved in the overall technology transfer of the AID hand pump to Honduras. The effort by these parties has been continuous and will go on as long as the PRASAR project continues. Hopefully, through the efforts of the USAID Mission, the AID hand pump will be used on other projects in other parts of the nation eventually. All parties are in agreement that locally manufactured hardware with all of its benefits should have priority over imports for employment generation, spare parts availability, lower costs of production and the subsequent lower cost for procurement (including lower cost of transportation), and lowering of foreign exchange requirements.

9. At the present time no additional AID hand pumps have been produced or sold by the manufacturer beyond those for the pilot program. This is an area (marketing) that needs attention if the technology transfer effort is to be successful.

10. The current USAID Mission staff and the Mission Director are aware of the technology transfer and private sector initiative aspects of the pilot program. Further, the Mission supports the philosophy of the technology transfer effort and is working to see that the use of the AID hand pumps spreads to other projects beyond that of PRASAR.

11. In retrospect, the AID hand pump program has gone well in Honduras. There have been many problems to contend with in teaching the manufacturer proper production and quality control techniques and in showing government engineers and technicians proper methods of well development as well as hand pump installation, maintenance and repair. However, these problems are inherent in such a development program.

ATTACHMENT 2

PROGRESS REPORT ON HAND PUMP TESTING PROGRAM

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

January 14, 1983

TO: Phillip W. Potts

FROM: B.S. Dixit

SUBJECT: Progress Report on Hand Pump Testing Program

Enclosed is the progress report on the hand pump testing program.

As you can see from the report, we are about to complete the durability test on two pumps. We did not have any major problems with these pumps. By about the first week of February, the 'Philippine shallow well pump' and the 'Honduras shallow well pump' will complete 10 million cycles.

The Philippine deep well pump and the Honduras deep well pump will complete 10 million cycles by about the third week of February, if we do not run into problems with our driving systems. This is somewhat earlier than the dates we anticipated in our October report, because, we did not run into major operational problems. Our test progress was helped by the availability of space heaters which allowed us to continue the testing through Christmas vacation - we were not sure of this when the last report was made.

The testing on the Haiti pump has been discontinued for reasons explained in the attached report.

We have added three new pumps, i.e. the DR shallow well pump, the DR deep well pump and the Ecuador deep well pump. At 43 strokes per minute, it will take a minimum of 180 days to complete the testing sequence over 10 million cycles. The breakdown is as follows:

162 days - actual running time for 10 million cycles;
8 days - inspection;
10 days - lubrication and maintenance

This does not allow for unforseen problems, such as breakdown of the motors, speed reducers, replacements, etc. The approximate dates of

completion of this project as stated in the enclosed table does **not** allow for this.

In view of the increased duration of testing and our experience with the pumps we have been testing, I suggest the following inspection sequence:

First inspection: 1,000,000 cycles and the subsequent ones at intervals between 1.2 to 1.8 million cycles. Please let me know if this is acceptable.

Two additional pumps and head simulation valves are being fabricated in the machine shop.

Thank you!

BSD/lbh

Attachment

# HAND PUMP TESTING PROGRAM

## (TEST PROGRESS)

| PUMP MODEL | DIAMETER | STROKE LENGTH | ACTUAL PUMP DISCHARGE FLOW RATE LIT/MIN | ACTUAL PUMP DISCHARGE FLOW RATE GAL/MIN | NUMBER OF CYCLES COMPLETED AS OF JANUARY 15, 1983 | TOTAL VOLUME OF WATER PUMPED (ESTIMATED GAL) | ESTIMATED* DATE OF COMPLETION 10 MILLION CYCLES |
|---|---|---|---|---|---|---|---|
| Honduras Shallow Well | 2.750 | 5" | 20.66 | 5.44 | $9.0 \times 10^6$ | 1,138,000 | 1st week of Feb. 1983 |
| Philippine Shallow Well | 3.00 | 5" | 24.20 | 6.40 | $9.5 \times 10^6$ | 1,400,000 | End of Jan. 1983 |
| Philippine Deep Well | 2.194 | 5" | 12.8 | 3.38 | $8.2 \times 10^6$ | 616,000 | 3rd week of Feb. 1983 |
| Honduras Deep Well | 2.750 | 5" | 20.4 | 5.39 | $8.0 \times 10^6$ | 986,000 | 3rd week of Feb. 1983 |
| Tunisian Deep Well | 2.12 | 5" | 10.80 | 2.95 | $3.4 \times 10^6$ | 210,000 | 2nd week of May 1983 |
| Haiti Deep Well | 3.06 | 5" | 23.6 | 6.18 | $0.150 \times 10^6$ | 21,500 | *Testing Discontinued |
| Ecuador Deep Well | 3.02 | 5" | | | Just Started | | End of July 1983 |
| DR Shallow Well | 2.716 | 5" | | | Just Started | | End of July 1983 |
| DR Deep Well | 2.716 | 5" | | | Just Started | | End of July 1983 |

*PLEASE SEE THE SHORT REPORT ON THIS PUMP.

*Haiti Deep Well Pump - (Preliminary Assessment)

The following information and assessment is based in our experience with the Haiti deep well pump during the testing period with respect to its durability and general performance. The principal components of the pump under our observation and the details of our study are summarized below:

CYLINDER:

material; PVC
observed internal diamter; 3.064" - 3.092
Comments: The internal surface was found to be uneven with ridges and depressions.

PINS AND BUSHINGS:

average diameters of pins: 0.605" - 0.635"
average diameter of bushings: 0.628" - 0.635"
Comments: They were observed to be soft ane some were defective. The average hardness values of pins and bushings are as follows:

Pins: 85 Rockwell B.
Bushings: 74 Rockwell B.

PUMP BODY AND COMPONENTS:

Comments: Cast iron components such as the pump body, pump base, pump cap, fulcrum and handle were observed to have blow holes - small and big.

PISTON HEAD ASSEMBLY:

The piston head was made of brass and had machined surfaces also. Small blow holes were observed in several areas and the assembly appeared to be structurally weak.

TEST RUN:

The pump was assembled and started on 10/21/82 and the delivery head was set at slightly over 100 feet.

At 73,000 cycles there was a major pump failure due to a breakdown in the piston assembly. Other components such as the leather cups, foot valve, etc., were in good condition. In comparison, we never had similar failures or problems at an early stage, with other pumps that we have been testing.

In order to assess the durability of other components, the piston assembly was replaced by another unit - not related to the Haiti pump - and the pump was allowed to run again. However at 142,000 cycles, leakage was observed at the pump base. Our efforts to correct the leakage problem were not successful and at 150,000 cycles we found it would take us a long time to correct the defects and restart the pump.

In our judgement, we felt that, in view of the failures and defects stated earlier, it would not benefit us to continue the testing of the pump.

The water discharge rate of the pump during the testing period was 6.30 gallons per minute which can be considered satisfactory.

TRIP REPORT: DOMINICAN REPUBLIC

JANUARY 23-29, 1983

BACKGROUND

Georgia Tech's involvement in the Dominican Republic with the AID hand pump began in early 1978 with an investigation into the feasibility of locally manufacturing the pump. The feasibility study showed, among other things, that the level of machine shop and foundry skills existed to produce the AID hand pump, the price of large quantity orders would be competitive in the world market, and the Dominican Republic had substantial areas where hand pumps were more appropriate than other available means for developing water sources.

A contract was signed in August 1978, between the USAID/Dominican Republic and Georgia Tech, which was implemented between August 1, 1978 and June 30, 1979. The objective of this project was to develop a local capability to manufacture the AID hand pump and to field test it under existing rural conditons. The USAID Mission was especially interested in the project because it was at the time negotiating an agreement (Health Sector Loan II) which was to install approximately 2,650 hand pumps in the western region of the country. Local manufacture of these 2,650 pumps was particularly attractive for prompter and more convenient availability of spare parts, generation of local employment, and possibly lower prices over imported pumps of comparable quality and durability.

Two local machine shop/foundries (INDUSTROQUEL and Astilleros Navales Dominicanos) were contracted to produce 12 shallow-well and 12 deep-well AID hand pumps each. The 24 pumps were manufactured, then inspected and received by Georgia Tech project personnel between late November 1978 and early January 1979. Of the 24 pumps, 21 were installed in the Cibao Valley

of the Dominican Republic, near Santiago. The remaining three pumps were used to provide spare parts.

The test pumps functioned well in the field even though they contained manufacturing deficiencies, especially relating to poor dimensional tolerances (this resulted in some components fitting too loosely while others tended to fit too tightly). It should be mentioned that 22 additional pumps were later manufactured for shipment to other countries as prototypes which showed significant improvement in quality. Georgia Tech's involvement in the Dominican Republic then ended with a one-week training seminar for Santiago hospital technicians in water quality analysis.

In early 1981, Georgia Tech was instructed by AID/Washington to purchase three shallow-well and three deep-well models of the AID hand pump from ETINCA. ETINCA is a foundry/machine shop in Santo Domingo that was supplying AID hand pumps for Health Sector Loan II because earlier competitive bidding eliminated the two pilot program suppliers. Metametrics, Inc., of Washington, D.C., also was instructed to purchase 14 deep-well models of the AID hand pump from ETINCA. All 20 pumps were to be shipped to the USAID Mission in Port-au-Prince, Haiti for installation as demonstration pumps by Georgia Tech. Unfortunately, the 20 pumps were of such terrible machining quality that they could not be installed in the field. ETINCA, concerned over the poor quality, admirably replaced the pumps with another 20 that were of somewhat improved quality, even though some remachining had to be done before installation in the field.

## TRIP ACTIVITIES

Sunday, January 23. Eastern flight 949 was taken by Messrs. McJunkin, Hofkes, Donaldson, Gerhard Tschannerl (World Bank) and Potts from Miami to Santo Domingo, Dominican Republic. We were met at the Hotel Continental in Santo Domingo by Mr. Justin Whipple, from ICAITI, who was already in the Dominican Republic preparing a life-cycle cost analysis of the AID hand pump.

Monday, January 24. The management/technical review team met with Dr. Oscar Rivera, USAID/Dominican Republic Health Officer, to discuss the purpose of our visit and the status of Health Sector Loan II. According to Dr. Rivera, Health Sector II requires that 2,600 hand pumps be installed over a five-year period ending November 1983 (this date probably will be extended). As of last December (1982), 759 pumps had been installed out of approximately 1,400 manufactured. Of 1,238 wells drilled by private contractors, 913 wells have produced water. Installation of the hand pumps is carried out by a privately contracted four-person team which receives 18 pesos ($18 U.S.) per installation. A second four-person installation team is being planned for speeding up the rate of installations. Maintenance of the pumps is handled by mobile teams of the Ministry of Health.

The review team, accompanied by Dr. Rivera, Mr. John Thomas (USAID Health Office), and Mr. Manuel Valdez (USAID Engineering Office), visited ETINCA in the afternoon. ETINCA management (Mr. Tobia Fernandes) reported that in addition to the 1,400 pumps manufactured for Health Sector Loan II, 53 pumps have been produced for the following:

1. 25 pumps for Church World Services which is considering ordering 25 more

2. 4 pumps for the Foundation for Community Development to be used as test pumps for making a decision on the purchase of an additional 200 pumps

3. 1 pump for a farm

4. 2 pumps for an executive of the Central Bank

5. 1 pump for a fireworks factory

6. 20 pumps for Haiti (previously discussed)

ETINCA is aggressively seeking new customers and new business as the present hand pump production is its only significant business.

ETINCA reported further that its major problem is quality control on items (hardened pins and bushings, leather cups, etc.) supplied by the Ministry of Health. It can refuse the items; however, it has no way of measuring hardness, even though it knows the pins and bushings have been running much lower than specifications. A lot of bushings have been rejected because they are not perfectly circular (out of round).

Approximately 350-400 hand pumps have been manufactured with significant design changes:

1. The inside diameter of the cylinder has been reduced from 2 3/4 inches to 2 inches. The piston assembly has been proportionately reduced in size.

2. The 1 1/4 inch opening in the pump base has been increased to 2 inches.

3. The leather (flapper) foot valve has been replaced by a plastic valve.

4. The pump spout has been lengthened and threaded for a reducer and nipple to smoothen the flow of water from the pump.

During a tour of the machine shop and foundry many extremely poor castings were observed. Most of these castings, especially the pump bases, had unacceptable voids (in this author's opinion). Machined pump components also were of very poor quality, especially threading and the hole alignment of handles, handle fulcrums, and caps. Jigs and fixtures were being used but they were inadequate because of loose tolerances that permitted pump components to be machined at varying dimensions. The above clearly showed

the necessity of a prequalifying technical evaluation of potential manufacturers to accompany competitive bids. Price alone cannot be the sole determination of what company is to be awarded the contract for manufacturing the pumps.

The foundry had a nice cupola (coke fired) with a 15 ton per eight hour shift capacity. The machine shop had adequate lathes, milling machines, drill presses, shapers, planers and small hand tools for manufacturing the AID hand pump.

There was no evidence of quality control inspection at ETINCA other than a 55 gallon drum of water for wet testing 10 percent of the finished pumps. The ETINCA manager, Mr. Fernandes, reported that his brother inspected all finished pumps before being released to the government warehouse where the pumps are stored until time for installation in the field.

From ETINCA, the review team visited the warehouse where finished pumps are stored. Because of complaints from the installation team in the field that too many defective pumps were appearing, the Ministry of Health began in December 1982 to closely inspect all pumps before officially receiving them from ETINCA. The inspector of the pumps reported that he rejected 38 of the last 110 pumps received and 92 of 200 pumps previously received. Most rejects (90-95 percent) were because of loose bushings and poor threading in the pump base. The warehouse had 376 pumps (303 modified deep-well and 73 traditional shallow-well models) accepted and stored.

From the warehouse, the review team visited a community (Haina) on the outskirts of Santo Domingo where a modified AID deep-well pump has been installed. The pump was installed over a 150 foot drilled well but was not working. Villagers reported that the pump quit working three days after installation, was repaired (PVC drop pipe separated), then quit working after another five days for unknown reasons.

Tuesday, January 25. The review team, accompanied by Dr. Rivera and a Dr. Herera (Ministry of Health project director for Health Sector Loan II), travelled to the southwestern part of the Dominican Republic around Azua to inspect pumps installed during the past two years. The following observations were noted:

1. Cruze de Ocoa--A traditional AID deep-well pump was examined. The pump was not lubricated, three bushings were missing, and it was working. However, villagers reported that the pump was not used because of brackish water. The well is reported to be 120 feet deep (static water level unknown).

2. Cruze de Ocoa--A traditional AID deep-well pump was examined. The pump was not lubricated, one bushing was missing, and it was working. However, villagers reported that the pump was not used because of brackish water even though it showed considerable wear (sliding blocks in particular). Pins showed little wear.

3. Las Mayitas--A traditional AID deep-well pump was examined. The pump was lubricated, bushings were loose, and it was working. The pump was being used even though the water is reported to be somewhat brackish. The well is reported to be 100 feet deep (static water level unknown). Pins showed little wear.

4. Las Mayitas--A traditional AID deep-well pump was examined. The pump was not lubricated, one bushing was missing and others were loose, and the pump was working. However, villagers reported that the pump was not used because of the taste of the water (high level of iron and chloride).

5. Los Ronchitos de Bani--A traditional AID deep-well pump, the first installed in the area two years ago, was examined. The pump was lubricated, the bushings were both loose and worn, and the pump was working. The pump was being used. Like the four previously inspected sites, the

upperstructure had been well prepared; however, drainage from the site was poor.

6. Los Ronchitos de Bani--A traditional AID deep-well shallow-well pump was examined. The pump was lubricated and working well. The bushings were loose. The pump was being used. The upperstructure was well prepared.

7. Los Ronchitos de Bani--A traditional AID shallow-well pump was examined. The pump was not lubricated, but was working well. The bushings were loose. The pins were not worn. The sliding blocks were slightly worn. The upperstructure was well prepared.

8. La Vuelta de la Paloma--A traditional AID deep-well pump was examined. The pump was lubricated and working. The bushings were loose and the sliding blocks were slightly worn. However, villagers reported that the well goes dry after about 20 buckets of water are pumped. The well is reported to be 120 feet deep (static water level unknown). The upperstructure was well prepared.

9. La Vuelta de la Paloma--A traditional AID deep-well pump was examined. The pump was not lubricated and not working too well (foot valve was leaking). The bushings and pins were worn. The well is reported to be 110 feet deep (static water level unknown). The upperstructure was well prepared.

10. Los Gengibris--A traditional AID deep-well pump was examined. The pump was not lubricated and not working (possibly no water in well). The bushings were loose. The well is reported to be 120 feet deep (static water level unknown). The upperstructure was well prepared.

11. Ojo de Agua--A traditional AID shallow-well pump was examined. The pump was not lubricated and not working (the well was dry). One bushing was missing (the casting had not been drilled and reamed for one). The upperstructure was well prepared.

12. Ojo de Agua--A traditional AID shallow-well pump was examined. The pump was not lubricated and was barely working (leaking foot valve). The upperstructure was well prepared.

13. Las Tablas--A modified AID deep-well pump was examined. The pump was not working but was being removed from the well by the maintenance team for repair. As the pump was disconnected from its anchor bolts and raised to disconnect the drop pipe, the drop pipe separated from the plastic coupling between a base nipple and the rest of the drop pipe. When the drop pipe was removed from the well, the foot valve cage assembly was found to be disconnected from the rest of the foot valve. The well is reported to be 85 feet deep (static water level unknown). The upperstructure was well prepared.

14. Las Tablas--A modified AID deep-well pump was examined. The pump was not working but will be repaired tomorrow (Wednesday, January 26). The upperstructure was well prepared.

Of the above 14 pumps examined, only four were properly lubricated. Seven of the 14 had brackish water, dry or nearly dry wells, or unacceptable taste due to a high level of iron and chloride. Almost all had loose or missing bushings. Of the 12 traditional AID pumps, two were not working (because of dry or possibly dry wells). Of the two modified AID pumps with PVC drop pipe and a plastic foot valve, neither worked. The Ministry of Health maintenance team at Las Tablas also reported that 10 modified AID pumps had been installed during the past two weeks and all were broken; and of some 40 of these models, approximately 20 were not working.

Wednesday, January 26. The management/technical review team, accompanied by Messrs. Rivera and Valdez, travelled to an area near Santiago where AID hand pumps were installed four years ago under the pilot manufacturing program. The following observations were noted:

1. El Pinito Sabaneta--A traditional AID shallow-well pump fabricated from steel (rather than cast iron) was examined. The pump was not lubricated, was missing all but one bushing, but working well. The pump was installed June 3, 1978.

2. El Pinito Sabaneta--A traditional AID shallow-well pump was examined. The pump was not working (no handle). The pump was installed December 21, 1978.

3. Burende (Santo Cerro)--A traditional AID deep-well pump was examined. The pump was lubricated and working well. However, the original bushings had been replaced with bushings made from galvanized iron pipe. The pins (original) were not worn. The pump was installed December 21, 1978.

4. Guaco--A traditional AID deep-well pump was examined. The pump was lubricated but not working for the past six months from what appeared to be a disconnected plunger rod. The pump was installed November 11, 1978.

5. Los Frometa--A traditional AID deep-well pump was examined. The pump was working well and lubricated. The bushings (original) were intact and showed no wear. The pump was being heavily used. The sliding blocks were slightly worn. The pump was installed September 27, 1978.

6. Ceiba de Madera--A traditional AID deep-well pump fabricated from steel was examined. It was lubricated and working well. The original sliding blocks had been replaced with roller bearings. The pump was being heavily used. The installation date of the pump was unavailable.

7. San Francisco Arriba--A traditional AID shallow-well pump fabricated from steel was examined. It was neither lubricated nor working (defective foot valve). The pump was disassembled and its foot valve replaced with one cut from an old leather shoe to put the pump into working order. The installation date of the pump was unavailable.

Of the above seven pumps, four were still working. The Ministry of Health obviously is not maintaining the pumps as it promised Georgia Tech project personnel in 1978. However, it is interesting that villagers have made a tremendous effort to keep the pumps working even though they have had no spare parts.

Before leaving the Santiago area for Santo Domingo, Dr. Rivera decided to have the Ministry of Health maintenance team replace all of the old pumps near Santiago with newly manufactured pumps. Dr. Rivera also decided to include the Santiago area in future routine visits by the Ministry of Health maintenance team.

Thursday, January 27. No activity. The day was spent writing this report.

Friday, January 28. The review team, accompanied by Messrs. Rivera and Thomas, visited Cedeno Industrial. Cedeno Industrial is the manufacturer that made AID hand pumps under the pilot program by the name of INDUSTROQUEL. Cedeno has moved to a larger, much nicer location, has a well-equipped foundry and machine shop, and still makes the AID hand pump. During the past four years Cedeno has sold 245 shallow-well pumps and 275 deep-well pumps to the private sector. The present price of the pump is 208 pesos ($208.00 U.S.), a price that probably could be negotiated downward for large orders. Cedeno claims that it has a hardness oven and hardens the pins and bushings itself; however, Cedeno management also claimed the oven was locked up and the key could not be found, so, the team could not verify whether or not the oven actually existed. Cedeno had no finished pumps available for inspection even though several cast components were exhibited that showed good casting and machining.

The price of 208 pesos by Cedeno is most likely negotiable. In comparison, the finished pump produced by ETINCA costs approximately 176 pesos which includes pins, bushings, leather cups, foot valves, etc. In other words, both manufacturers are or can be very competitive. Using hindsight, this author is of the opinion that choosing ETINCA as the supplier of pumps for

Health Sector Loan II was a major mistake by the Government of the Dominican Republic. This opinion is reinforced by unvalidated reports that ETINCA was a machine shop (only) when it submitted its quote for manufacturing the AID hand pump. After being awarded the manufacturing contract, ETINCA integrated its foundry operations into the business.

Saturday, January 29. Air Florida flight 130 was taken from Santo Domingo to Port-au-Prince, Haiti to conclude Dominican Republic activities.

## CONCLUSIONS AND RECOMMENDATIONS

1. The Dominican Republic is in an advanced stage of the overall technology transfer effort involving the AID hand pump. The hand pumps manufactured under the pilot manufacturing program were supposed to be maintained by the Ministry of Health; however, maintenance is now up to untrained rural villagers who do not have access to spare parts. Yet, despite the circumstances, after four years of improvising, the villagers are keeping the pumps operating in some cases.

   Under Health Sector Loan II, hand pumps are being manufactured in large quantities. Some 759 pumps, out of 1,400 manufactured, have been installed. The traditional AID design pumps are still functioning at test sites. A modified version of the AID hand pump using PVC drop pipe and a plastic foot valve is not working at test sites. Unfortunately, the modified pump is being installed at a rapid rate with approximately 50 percent of the pumps failing within several weeks. Procedures should be set into motion to quickly determine the failure points of the modified pump and then implement corrective action before significant numbers are installed in the field. If the causes and remedies cannot be quickly determined, the traditional design should be re-instituted.

2. Of the two original manufacturers, INDUSTROQUEL and Astilleros Navales Dominicanos, only INDUSTROQUEL was visited by the management/technical

review team. INDUSTROQUEL, now operating under the name of Cedeno Industrial, is still producing AID hand pumps according to the original specifications. The present suplier of AID hand pumps to Health Sector Loan, ETINCA, is manufacturing a modified pump using PVC drop pipe and a plastic foot valve. This modified pump is not performing well in the field. Of equal seriousness is the fact that ETINCA is not manufacturing a quality pump, traditional or modified design. It is imperative that technical assistance be provided ETINCA for tightening of quality control through proper manufacturing inspection procedures. If technical assistance cannot be provided, and quickly, manufacture of the AID hand pump in the Dominican Republic should be immediately halted.

3. Other donors and host country organizations are not using the AID hand pump design and the manufacturer sponsored by AID in technical assistance.

4. Both Cedeno (the original manufacturer) and ETINCA (the present supplier to Health Sector Loan II) are selling hand pumps to the private sector. Cedeno has sold approximately 520 pumps to the private sector and ETINCA, some 53 pumps. Cedeno, naturally, has sold many more pumps than ETINCA because it has been manufacturing the AID hand pump much longer (approximately two years longer). Cedeno also has had much more time to establish its marketing channels while ETINCA is in the early stages.

5. AID hand pumps installed under the pilot manufacturing program are in some cases being maintained. However, because the Ministry of Health was originally designated to maintain the pumps and keep an inventory of spare parts (which it is not doing), community (village) caretakers were not trained in maintenance and repair. Despite these caretakers not being previously trained and after four years of improvising, the villagers are keeping the pumps operating in some cases.

AID hand pumps installed under Health Sector Loan II are also being maintained, but mostly by a Ministry of Health mobile maintenance team rather than by village caretakers. Of the 12 traditional AID hand pumps inspected, two were not working (because of dry or possibly dry wells). Of the two modified AID pumps inspected with PVC drop pipe and a plastic foot valve, neither worked. The Ministry of Health maintenance team at Las Tablas also reported further that 10 modified AID pumps had been installed during the past two weeks and all were broken; and of some 40 of these models, approximately 20 were not working.

6. Since Health Sector Loan II is still underway, the Ministry of Health is still operationally involved in the installation, operation and maintenance of the AID hand pump. Installation is handled by a contractor that receives 18 pesos ($18.00) per installation, and an average of five installations are made per day (up from an average of three installations per day when the Ministry of Health previously installed the pumps). Maintenance is handled by a Ministry of Health mobile team that constantly travels the project area repairing broken pumps and performing routine maintenance. A second mobile team is planned for the near future.

7. The total cost of the AID hand pump manufactured by ETINCA is now approximately $176, which includes some $40 of components purchased and supplied to ETINCA by the Ministry of Health. Cedeno Industrial is quoting a price of $208, a price that probably could be negotiated downward. Both prices are close to those paid during the pilot manufacturing program of $200. However, buying on price alone can be very misleading as the present situation in the Dominican Republic well exemplifies. If ETINCA had been subjected to a prequalifying technical evaluation, it would most likely have been disqualified as an acceptable supplier. In other words, price alone cannot be the sole determination of what company is to be awarded the contract for manufacturing the AID hand pump.

8. The USAID Mission and the Government of the Dominican Republic are taking a very active, continuous role in the overall AID hand pump technology transfer effort. Both parties fully realize the benefits of local manufacture and are ambituously working toward a successful outcome. Both parties also realize that there are manufacturing problems that must be solved and have just recently installed a pump inspector at the government warehouse where the manufactured hand pumps are delivered by ETINCA. This pump inspector is displaying an admirable toughness and diligence as shown by the fact that he is refusing to accept 40-50 percent of the pumps he receives from ETINCA. Unfortunately, this same rigorous inspection is not being done by ETINCA personnel at ETINCA and too many poor quality pumps are being released by the manufacturer.

9. The pilot manufacturer, Cedena Industrial, is continuing to manufacture the AID hand pump even though ETINCA is mass producing it for the Government of Honduras. Since the pilot program, Cedena has manufactured and sold 245 shallow-well pumps and 275 deep-well pumps. ETINCA has manufactured approximately 1400 pumps from a total order of 2,050 by the Government of Honduras (the present order is for 1,050 pumps).

10. As mentioned previously (item 8), the USAID Mission and the Government of the Dominican Republic are taking a very active, continuous role in the overall AID hand pump technology transfer effort. Both parties also support the concept of local manufacture over importing if it is practical (feasible), whether it be from an overall development standpoint or specifically for health projects.

11. Unfortunately, there are several lessons to be learned from what has been observed in the Dominican Republic. The selection of a foundry/machine shop for producing AID hand pumps should be made on the basis of expected quality and price, not price alone. Technical assistance to the manufacturer must begin at the start of manufacture and be consistent throughout the production process. The

foundry/machine shop producing the pump must be responsible for a complete pump, not just various components. The manufacturer must have quality control procedures in place, rather than depending on the purchaser to catch its defects. The problems with the PVC drop pipe and plastic foot valve are similar to those experienced by Georgia Tech in Tunisia, yet, these Tunisian experiences were ignored in the Dominican Republic.

TRIP REPORT: HAITI

JANUARY 30 - FEBRUARY 1, 1983

BACKGROUND

Georgia Tech received authorization from the WASH Project in August 1981 to carry out activities in Haiti as specified under OTD 46. In general, this OTD called for selecting well sites in Haiti and installing Dominican Republic manufactured AID hand pumps; identifying and developing a realistic long-term hand pump maintenance system; training in-country personnel in hand pump installation, maintenance and repair; and conducting an assessment of the feasibility of local manufacture of the AID hand pump.

Twenty AID hand pumps manufactured in the Dominican Republic arrived in Port-au-Prince, Haiti the latter part of 1981. Georgia Tech project personnel, however, were unable to install the pumps because of poor quality (threading of the pump base would not accept drop pipe, end caps of cylinders could not be screwed onto the cylinder because of poor threading, the piston cage could not be screwed onto the rest of the piston assembly because of poor threading, pins and bushings were not properly hardened and bushings were not press fitted). The 20 defective pumps were replaced by the Dominican Republic manufacturer, ETINCA, with somewhat improved pumps that could be installed after minor reconditioning. Sites were selected and pumps installed in the area of Camp Perrin, Haiti. Installation and maintenance of the pumps was delegated to a UNDP-sponsored foundry/machine shop school, Atelier Ecole. Atelier Ecole personnel also were trained in installation, maintenance and repair procedures. Production patterns, working drawings and a prototype of the AID hand pump were provided to a Port-au-Prince foundry/machine shop, Founderie National. Founderie National has now produced 20-30 AID hand pumps--the quality has not been very good. For instance, Georgia Tech has laboratory tested a Founderie National pump, but the test was discontinued at 150,000 cycles because of a

piston breakage (high porosity) at 73,000 cycles and severe leakage at 142,000 cycles where the pump body screws into the pump base. Other defects with the Founderie National pump have resulted from soft pins and bushings and their poor press fit into the pump components.

For the benefit of the reader, there are 13 sites with 16 AID hand pumps installed near Camp Perrin. These sites are described as follows (SW = shallow-well, DW = deep-well):

| | Location | Well Type | Depth to Water Level | Depth to Well Bottom | Approximate Number of Houses in Community |
|---|---|---|---|---|---|
| 1. | Madeque-1 SW | dug | 10' | 27' | 125 |
| 2. | Archambeau-2 SW | dug | 10' | 30' | 125 |
| 3. | Regis-2 SW | dug | 10' | 47' | 125 |
| 4. | Mizine-1 DW | drilled | 41' | 71' | 150 |
| 5. | Barthe-1 DW | drilled | 12' | 36' | 150 |
| 6. | Nabanbou-1 SW | dug | 3' | 21' | 100 |
| 7. | Achile-1 SW | dug | 17' | 23' | 100 |
| 8. | Gwen #2-1 SW | dug | 13' | 21' | 125 |
| 9. | Anadere #1-1 SW | dug | 18' | 28' | 300 |
| 10. | Anadere #2-1 SW | dug | 6' | 18' | 200 |
| 11. | Taivan-2 DW | dug | 41' | 55' | 125 |
| 12. | Kans-1 DW | drilled | 90' | 200' | 200 |
| 13. | Gwen #1-1 SW | dug | 13' | 23' | 125 |

## TRIP ACTIVITIES

Saturday, January 29. Messrs. McJunkin, Donaldson, Whipple and I flew from Santo Domingo, Dominican Republic to Port-au-Prince, Haiti on Air Florida flight 180.

Sunday, January 30. Mr. Frank Temmel, consultant to USAID/Haiti, and Mr. James Gardner, USAID/Haiti, picked up the review team, plus Justin Whipple,

at 6 A.M. this morning. From the Hotel Castelhaiti we proceeded to the Port-au-Prince airport and then flew to Loganave Island in a small plane (Cessna 310). After arriving on Loganave Island we were joined by Mr. Harry Proctor (USAID/Haiti), Mr. William Granger (USAID/Haiti), and two men from the Peace Corps.

While on Loganave we visited seven sites where Moyno pumps have been installed by Compassion International. Observations at these sites were as follows:

1. Baie Tortue--The pump at this site was installed in July or August of 1982. It had been inoperable since October of 1982. Interestingly, the handle would rotate backwards (which it is not supposed to do).

2. Fond Pouissiere--The pump at this site was installed in July or August of 1982. It was working well and being used by many people. Users reported that they had walked 24-28 kilometers, round trip, for water prior to the pump's installation.

3. Morne Chandelle--The pump at this site was installed in March of 1981. It was working well and being used by many people.

4. Palma I--The pump at this site was installed approximately two years ago (exact date not available). It was working well and being used by many people.

5. Palma II--The pump at this site was installed approximately two years ago (exact date not available). It was working well and being used by many people.

6. Fond L'Aurora--The pump at this site was not working. It was reported to be losing its prime and would work after 20-30 minutes of hard rotation of the rotor. The well here was reported to be 215 feet deep.

7. Nan Mangot--The pump at this site was working well and being used by many people. However, the handle would rotate backwards.

Of the seven sites visited, five pumps were working. It was disappointing to find the two other pumps not working because the Moyno pump was designed to operate for four to five years without maintenance. The pumps observed by the team had been in use two years or less.

Monday, January 31. Mr. Temmel and Mr. Gardner picked up Mr. McJunkin, Mr. Whipple and me at the hotel early this morning to go to Camp Perrin. At Camp Perrin we stopped at the Atelier Ecole to pick up the school's director, Mr. John Bernard Sugeir. However, Mr. Sugeir was out repairing AID hand pumps. We then proceeded to the general area where AID hand pumps have been installed and noticed the following (Mr. Sugeir was at the first site, Taivan):

1. Taivan--Two deep-well pumps have been installed here. Both pumps had just been repaired (the plunger rods had broken at the rod end). The well also was being cleaned out and deepened. The pumps were well lubricated and reportedly being used by over 1,000 people.

2. Madeque--A shallow-well pump has been installed here. It was not working, had a missing sliding block, one bushing was missing, several bushings were loose, and the plunger rod was disconnected from the rod end. The pump reportedly had been out of operation for approximately 15 days.

3. Regis--Two shallow-well pumps have been installed here. Both were working well and were lubricated. The bushings and pins appeared to be in good shape. Mr. Sugeir reported that there had been problems with the plunger rod breaking at the rod end.

4. Archambeau--Two shallow-well pumps have been installed here. Both were working well and were lubricated. Mr. Sugeir reported that these two

pumps had presented no problems and were being used by over 2,000 people.

5. Gwen #2--A shallow-well pump has been installed here. It was working well and was lubricated. Mr. Sugeir reported that pump had presented no problems.

6. Gwen #1--A shallow-well pump has been installed here. It was not working, one bushing was badly worn on the inside, the plunger rod was worn from rubbing against the side of the pump cap hole, and the fulcrum pin was worn. It appeared that the geometry of the handle fulcrum, the handle and/or the rod end was misaligned and had caused this unusual wear.

7. Kans--A deep-well AID pump has been installed here. It was not working because of what appeared to be a broken plunger or a disconnected plunger rod.

Of the 10 pumps inspected, seven were working. Of considerable importance is that all sites have extremely heavy usage. The villagers also were noticed to be very rough on the pumps, pumping fast and pumping to the extreme of each stroke. In regard to the breaking of the plunger rod, Mr. Sugeir and Mr. Temmel had earlier believed that this was the result of inferior Haitian rod. However, Mr. Sugeir has replaced some of the rod with pieces imported from France and gotten the same results. The looseness of some of the bushings was the result of poor drilling and reaming by Atelier Ecole when Dominican Republic pins and bushings were replaced with some hardened to meet standard specifications.

Note: Since this trip to Haiti there has been a plunger rod breakage on a Dominican Republic shallow-well pump being laboratory tested at Georgia Tech. Strangely, the break occurred at a point where the rod end butts up against a lock nut, not below the lock nut as might be expected. This

break appears to have been the result of the Dominican Republic manufacturer, ETINCA, drilling and threading the hole into the rod end at a slight angle, leading to a flexing of the plunger rod at the plunger rod/rod end interface. The plunger rod then fatigued in the thread route to the point of failure. The entire situation will be investigated further at Georgia Tech and in Haiti when the next field engineer is at Camp Perrin. The field engineer also will take a supply of hardened pins and bushings with him and recondition any pump caps, handles and handle fulcrums that are of substandard quality.

Tuesday, February 1. Mr. Whipple and I took Air Florida flight 180 from Port-au-Prince to Miami. From Miami, I flew to Atlanta and Mr. Whipple flew to Guatemala City, Guatemala. Mr. McJunkin and Mr. Donaldson stayed in Haiti for a training workshop on rural water supply and sanitation.

## CONCLUSIONS AND RECOMMENDATIONS

The Moyno hand pumps installed by Compassion International on Loganave Island are, for the most part, working. However, it was disappointing to find two out of seven inspected not working. In absolute terms, to find only two inoperable pumps is not bad considering that these pumps receive no maintenance or repair and are being constantly used. On the other hand, the Moyno pump is designed and advertised to require minimal maintenance; for instance, only the grease in the gear box should be changed during the first four to five years. Unfortunately, there is no such thing as a maintenance-free pump, and the USAID Mission, as the funding agency for the procurement and installation of these pumps at Loganave, should make provisions for at least minimal attention to these pumps. At least on an annual basis, personnel and spare parts should be made available to bring these pumps back to a working condition.

Of the 10 AID hand pumps inspected, seven were working. As with the Moyno pump, the AID pumps have very heavy usage. Fortunately, and unlike the Moyno pumps on Loganave Island, the AID hand pumps are being maintained and

repaired by Atelier Ecole. Unfortunately, the AID hand pumps are not of top quality and, using hindsight, probably should never have been installed in Haiti. For the future, Georgia Tech field engineers should study the problem of the plunger rods breaking at the rod end and do their best to make long-term corrections. Also, any pumps that show weaknesses in the field should be brought up to an acceptable level of quality to minimize maintenance requirements and to provide a more reliable source of water. It should be noted that these problems are not insurmountable and can be resolved by the end of March 1983.

# RECOMMENDATIONS

## SRI LANKA

1. The Ministry of Local Government, Housing and Construction, along with the National Water Supply and Drainage Board is planning to hire and train pump mechanics who will work closely with village caretakers in maintaining and repairing hand pumps. However, under the best of conditions several months will most likely be required to implement their plans. Until the pump mechanics are carrying out their functions effectively, it is recommended that the USAID Mission make someone available to monitor the pumps on a monthly basis with timely reporting to the District Development Councils and the Ministry of Local Government in Colombo of any pumps that cannot or are not being maintained or repaired.

2. The AID hand pump manufacturer, Somasiri Huller Manufactory, has modified the base of the pump. The modification, overall, has been well thought-out and should be considered for adaptation to all AID hand pumps. However, the modification has both advantages and disadvantages when compared to the standard design, and it is unclear which design is superior. Thus, the modification should be carried further to eliminate the disadvantages and then weighed against other possible alternatives.

3. It is highly recommended that the foot valve design used with the AID hand pump manufactured in the Philippines or one of equal (or greater) durability be substituted for the flapper valve now being used in Sri Lanka. The Philippines foot valve has shown very good results in laboratory tests at Georgia Tech, and reports from the field show similar results.

THE PHILIPPINES

1. The AID hand pump program has gone well in the Philippines. However, the overall technology transfer effort is not finished. Future orders for the AID hand pump should include limited technical assistance.

2. Marketing emphasizing the advantages of the AID hand pump over other commercially available or imported hand pumps has been practically nonexistent. In regard to marketing, it is strongly urged that AID hand pumps be promoted for use in other AID health programs and that other development agencies (for instance, the U.S. Peace Corps) be made aware of the effectiveness of AID hand pump programs.

3. A systematized procedure for obtaining spare parts has not been worked out yet because of the limited number of pumps in the field and because spare parts have not yet been needed. However, the time will come when spare parts are needed and the USAID Mission is strongly urged to arrange as quickly as possible for at least a minimal inventory of these spare parts at the provincial engineer's offices where AID hand pumps are installed.

INDONESIA

1. The AID hand pump manufacturer, P. T. Celco, is not adhering to manufacturing specifications established during the AID hand pump pilot program. It is highly recommended that short-term technical assistance be provided as soon as possible for the pumps for convincing management of the dangers of deviating from specifications that have been determined to be valid and sound in other countries. From this technical assistance, P. T. Celco hopefully would enter into a contractual arrangement with Metal Industries Development Centre for the establishment of formal standards, inspections, and certification to the standards.

2. The practice of leaving spare parts, kits, and tool boxes with the village caretakers should be adopted for all countries where AID hand pump programs are being implemented. The spare parts kits also should conspicuously display a label with information telling where additional spare parts might be purchased.

3. Not only is CARE doing an excellent job in continuing the AID hand pump program in the Bandung area, it has expanded the program to Lombok. While CARE and the USAID Mission should be congratulated for their diligence in this endeavor, it is felt that the time is right for short-term technical assistance that will allow "fine-tuning" of procedures in water quality analysis, installation, maintenance and repair. Also, it seems appropriate that AID/Washington and/or the USAID Mission in Indonesia should further investigate this successful example of technology transfer and disseminate their findings for inclusion in other, similar efforts through a case study.

4. As with Sri Lanka, it is highly recommended that the foot valve design used with the AID hand pump manufactured in the Philippines or one of equal (or greater) durability be substituted for the flapper valve now being used in Indonesia.

HONDURAS

1. It is strongly recommended that a foot valve design used with the AID hand pumps manufactured in the Philippines or one of equal (or greater) durability be manufactured in Honduras and retrofitted to the hand pumps already manufactured.

2. The USAID/Honduras Mission is pursuing alternative markets for the manufacturer, FUNYMAQ, since the PRASAR project is behind schedule and most likely will not advance to the point where AID (FUNYMAQ) hand pumps are needed. This marketing effort by the Mission is encouraged

because the AID hand pump is appropriate to the Honduran environment. In order to complete the technology transfer effort further technical assistance is recommended in this area (marketing). At the same time, technical assistance should be given to a second possible manufacturer for competitive pressure in keeping the AID hand pump price down and its quality up.

DOMINICAN REPUBLIC

1. The spout of the AID hand pump now being manufactured in the Dominican Republic has been lengthened and threaded for a reducer and nipple to smoothen the flow of water from the pump. It is recommended that this modification be adopted for future AID hand pump manufacturing programs.

2. The AID hand pump manufacturer, ETINCA, was selected through competitive bidding by price alone. It is recommended that any future selection of such a pump manufacturer include a technical evaluation to avoid the unacceptable quality of hand pumps evidenced in the Dominican Republic.

3. The Ministry of Health maintenance team has reported that 10 modified AID hand pumps had failed within two weeks after installation; and of some 40 of these models, approximately 20 were not working. It is imperative that the cause(s) of these failures be determined and corrective measures established or that the use of the modified hand pump be discontinued.

4. Quality control by the manufacturer, ETINCA, is practically nonexistent. Technical assistance is needed quickly, especially in casting of the base, machining, proper use of jigs and fixtures, press fitting of bushings, and hardening and testing of pins and bushings.

HAITI

1. Moyno hand pumps installed on Loganave Island have not been provided with maintenance and repair support service. The USAID Mission, as the funding agency for the procurement and installation of these pumps, should make provisions for at least minimal attention. At least on an annual basis, personnel and spare parts should be made available to bring these pumps back to a working condition.

2. In regard to the AID hand pumps installed near Camp Perrin, Georgia Tech engineers should study the problem of the plunger rods breaking at the rod end and do their best to make long-term corrections. Also, any pumps that show weaknesses in the field should be brought up to an acceptable level of quality to minimize maintenance requirements and to provide a more reliable source of water. It should be noted that these problems are not insurmountable and can be resolved by the end of March 1983.

GENERAL RECOMMENDATIONS

1. The concept of hardened pins and bushings is valid. Even under the extreme conditions of little, if any, lubrication found in Sri Lanka the pins and bushings have shown negligible wear. However, without lubrication, the AID hand pumps were found to be very difficult to operate because of the increased friction that resulted. Alternatives should be investigated that might eliminate the need for lubrication, such as sealed bearings or Teflon-coated pins and bushings.

2. It has not been stressed previously in this report that the AID hand pump is now called the Diasson pump in Sri Lanka, the BWP pump or the Tri-Star pump in the Philippines, the Sumber Banyu (source of water) pump in Indonesia, the FUNYMAQ pump in Honduras, and the ETINCA pump in the Dominican Republic. Encouragement should be given in all countries

where the AID hand pump is being manufactured to adopt an indigenous name. This would greatly enhance the national pride of manufacturers, government procurement personnel, and village users when they associate the pump as a product of their own making rather than an import or a product of an American development agency.

3. Many developing countries do not have the manufacturing capabilities for producing cast iron products such as the AID hand pump. Consideration should be given to using the Magsaysay design where the AID hand pump is inappropriate.

4. Hardness specifications should be established for the AID hand pump's sliding blocks. A recommended hardness is 10-20 points lower on the Rockwell scale than the cast iron pump cap.

5. Most traditional deep-well hand pumps have used a cylinder/drop pipe arrangement where the drop pipe is smaller in diameter than the cylinder to maximize water volume delivery and to minimize difficulty and cost of installation. For instance, the AID hand pump ordinarily is installed with a 1.25-inch diameter galvanized iron drop pipe and a 2.75-3.00-inch diameter cylinder. Consideration should be given to using drop pipe of a size slightly greater than the cylinder so that the piston assembly can be pulled up through the drop pipe when leather cups require replacement. This would minimize maintenance significantly. However, caution should be exercised while making the decision on this approach. Galvanized iron drop pipe, even 1.25 diameter, is heavy and requires three to four persons during installation. Greater diameters would most certainly require a tripod. PVC drop pipe is much lighter and easier to handle. However, it (PVC) requires clamping to the sides of the well to prevent its swinging during the hand pump's operation. Also, experiences in Tunisia by Georgia Tech personnel have been unfavorable with PVC pipe separation at the pipe joints, a situation that may have been due to the composition of the PVC.

6. Multiple hand pump installations are recommended over dug wells where the diameter of the well is great enough and the population density is large enough. Two or more pumps per well not only leave a backup pump in case one fails, but, as well, alleviates some of the waiting in line to use the pump. The latter can become a serious problem when well users have been accustomed to an open well where many people can draw water at the same time.

7. In the past, the technology transfer process has been considered to be complete after establishing manufacturing capabilities, field testing and evaluating the manufactured pumps, and training engineers and technicians in pump installation, maintenance and repair. It now appears that follow-up marketing assistance is necessary if the assisted manufacturer is to maintain a long-term effort in producing the pump.

8. The technical/management review of the AID hand-operated water pump program has been enlightening. There is, without a doubt, an obvious need for short-term follow-up technical assistance in each of the countries visited to implement previously mentioned recommendations for a long-term technology transfer success. It is recommended, and hoped, that AID/Washington and/or the USAID Missions will authorize and fund this follow-up technical assistance in Sri Lanka, the Philippines, Indonesia, Honduras, the Dominican Republic, and Haiti as early as possible.